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CANADIAN AIRSPACE SYSTEM

ME I SYSTEM ENGINEERING MANAGEMENT IMPLEMENTATION PLAN FOR THE CANADIAN AIRSPACE SYSTEM

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JANUARY 1985

TP6069E

CANADIAN AIRSPACE SYSTEM

VOLUME 1: SYSTEMS ENGINEERING MANAGEMENT IMPLEMENTATION PLAN FOR THE CANADIAN AIRSPACE SYSTEM

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TRANSPORTATION DEVELOPMENT CENTRE

JANUARY 1985

The contents of this report reflect the views of the contractor and not necessarily the official views or policies of Transport Canada.

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17. Abstract

The Canadian Airspace System Plan (CASP) is a comprehensive plan for modernizing and improving the Canadian Airspace System. There are literally thousands of air traffic control and air navigation facilities comprising the Canadian Airspace System. Projects to modernize these facilities are in various stages of implementation. Implementation of some projects may dictate changes in, or alterations to, air traffic procedures, aircraft equipage, or flight procedures as well as impacting other projects. The Canadian Airspace Systems Engineering Plan describes a unique systems engineering based approach for organizing and managing the implementation of CASP.

Volume 1: Systems Engineering Management Implementation Plan: This report describes a series of systems engineering planning activities and processes; structures the many individual projects in the Canadian Airspace System Plan; describes a program management hierarchy; identifies tools available to support management; estimates the number of person-years of technical/engineering support required; mandates a series of specific actions required; and, reports progress on their implementation.

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17. Abstract

Le Plan d'aménagement de l'espace aérien du Canada vise à moderniser l'organisation et la gestion de cet espace dont la surveillance fait appel à un nombre très élevé d'installations pour le contrôle de la circulation aérienne et la radionavigation. Ce Plan met en oeuvre un grand nombre d'actions ayant atteint un stade plus ou moins avancé et dont certaines implequent des modifications aux procédures de circulation aérienne ou de vol en vigueur, ou aux normes d'équipement des aéronefs. Pour la réalisation de ce Plan, une approche systémique est préconisée dans ce rapport.
Le rapport comporte cinq parties:
Volume 1: Systems Engineering Management Implementation Plan; ce rapport décrit ou définit: les actions à lancer et les procédés à appliquer en matière de planification; l'ordonnancement général des nombreux éléments du Plan; les liaisons hiérarchiques à établir; les services de soutien au programme de gestion; le tableau estimatif des effectifs techniques à prévoir; et enfin, les progrès accomplis.
Les autres parties traitent plus en details des sujets suivants:
Volume 2: Program Management System (System Description);
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Volume 4: Level I System Design (to facility level);
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FOREWORD

There is a striking parallel between the Canadian Air Traffic Control and Air Navigation electronic infrastructure and that in the United States. Equipment is old, it is becoming increasingly difficult and expensive to maintain, and spare parts are becoming increasingly difficult to obtain. Not only is much of it technologically obsolete, but it is rapidly becoming functionally obsolete. The equipment is rapidly becoming unable to support the requirements being placed on it.

It therefore must be replaced.

Both Canada and the United States have wisely opted to handle the replacement and modernization activity using a System Engineering approach. Inasmuch as essentially the same problems are being addressed in essentially the same manner in both countries, it seems fair to argue that what has been said about the United States' effort is equally applicable to the Canadian effort. The Director of the U.S. Congressional Budget Office, in testimony before the Congress in April 1983, said: "The weight of technical opinion is that we must modernize the nation's air traffic control infrastructure. The economic question is how and when to do this? Our appraisal indicates that, if fully implemented, the FAA plan offers the nation a sound economic investment. Indeed, such an investment appears overdue....

....System modernization seems to be overdue and the FAA's National Airspace System Plan appears to offer the nation good value for its money. This conclusion holds even after allowing for a wide band of uncertainty in some of the Plan's underlying assumptions...."

The System Engineering approach adopted by the Canadian Air Transportation Administration is the most cost effective way to address the modernization question. Such an approach recognizes that there are high levels of interaction between systems. Virtually every system improvement is coupled to a number of other improvements. Recognizing and taking account of these interactions which make the Systems Engineering approach significantly more cost effective than a "piece meal" approach. The Systems Engineering approach recognizes that decisions depend on each other and the sum of the total is always greater than the sum of the parts.

A feature of Canada's air traffic control and air navigation electronic infrastructure is that the various components making up these systems are highly interrelated. Little can be done to change one part of the system that does not impact elsewhere. This interrelatedness makes it costly and difficult to introduce change on a "piece meal" basis. It would be technically and financially imprudent to attempt to implement less than the entire Canadian Airspace Systems Plan.

It is in this context that the Systems Engineering Management Implementation Plan for the Canadian Airspace System has been prepared.

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CHAPTER 1

OVERVIEW

1.0 OVERVIEW

This document sets out a System Engineering Management Implementation Plan for the Canadian Airspace System.

The Canadian Airspace Systems Plan is a comprehensive plan for modernizing and improving the Canadian Airspace System. The work envisioned is almost overwhelming in its magnitude. The activities described are so large and complex that they must be addressed in a System Engineering context if there is to be any hope of successfully implementing the Plan in any reasonable timeframe and at any reasonable cost.

In preparing this Plan for implementing the Canadian Airspace Systems Plan, a number of factors were taken into consideration.

The long term support of the aviation community and the public is important. The continued support of aviation users and the public is likely dependent on delivery of some benefits in terms of enhanced safety, improved services, or reduced operating costs early in the implementation period. Achieving these early benefits will require a very carefully orchestrated integration of project outputs.

There are literally thousands of Air Traffic Control and Air Navigation facilities comprising the Canadian Airspace System. Some are to be retained, others are to be modified, and some are to be replaced in the modernization. All are providing critical services to the Canadian aviation community. Those services cannot be denigrated during implementation activities.

During the life of this program, Operational Performance Requirements will change. These changing requirements will be the result of changes in demand placed on the system or the emergence of changed or new technologies. Provisions must be made in the implementation plan to accommodate these changes even as the Program is moving forward.

The projects comprising the Canadian Airspace Systems Plan are in various stages of implementation. Some are currently being installed in the field, others are in production, others are being planned, and some are yet to be developed. It is almost axiomatic that those activities which are nearest to completion are those which we can change the least (without disrupting the entire activity) and those which are the furthest from completion are more susceptible to change (again without disrupting the entire activity). Although this reality is a significant constraint on any implementation scheme, it must be accommodated.

Implementation of some systems dictate changes in, or alterations to, air traffic procedures, aircraft equipage, or flight procedures.

During every phase of activity, from planning, to design, to implementation, care must be taken to assure that any corresponding air traffic procedures required are practical and will be available. The same is true of aircraft equipage and flight procedures.

This document describes a unique System Engineering based approach for organizing and managing the implementation of the Canadian Airspace Systems Plan. The approach proposed not only accommodates the foregoing concerns, it also provides a sound basis for assuring that the Canadian Airspace Systems Plan is responsive to all legitimate requirements and that it can be implemented in a reasonable time frame at the lowest practical cost.

Specifically, this report:

- o Describes a series of System Engineering planning activities and processes which allow the identification of Operational Service Requirements and Operational Performance Requirements to proceed in parallel with System Design.
- o Structures the many individual projects in the Canadian Airspace Systems Plan into a framework of 12 major projects.
- o Describes a program management hierarchy made possible by "bundling" the individual projects into major projects.
- o Identifies tools available to support management of the implementation of the Canadian Airspace Systems Plan.
- o Describes the number of person years of technical/engineering support required to accomplish those actions and implement the Canadian Airspace Systems Plan while at the same time continuing to provide support of field maintenance and other ancillary activities with which the Facilities Engineering and Systems Development Branch is charged. Although not quantified, the person year impact of all these activities on Offices of Collateral Interest is acknowledged and must be accommodated.
- o Mandates a series of specific actions required to ensure that the Canadian Airspace Systems Plan is and remains responsive to all appropriate requirements and that it will be implemented in a reasonable time frame at the lowest possible cost.

1.1 SYSTEM ENGINEERING PLANNING AND DESIGN

The classical approach to project engineering is one in which planning, design, project execution (production), implementation, and maintenance and operation are performed serially as depicted in Figure 1-1. There is no question as to the efficacy of that approach when addressing a requirement (or a group of requirements) with a single project.

CLASSICAL APPROACH TO PROJECT ENGINEERING

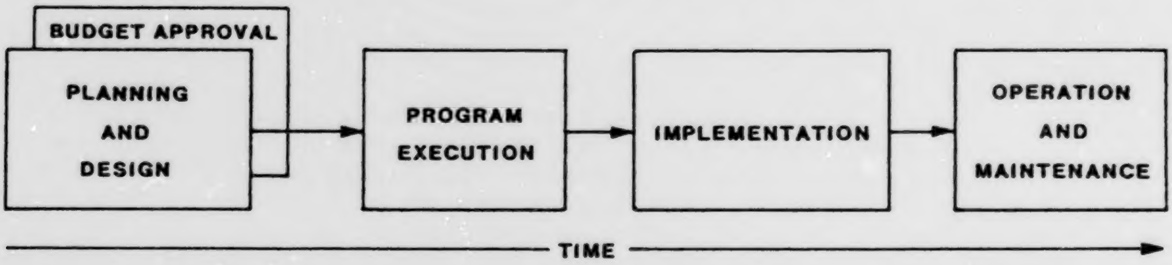


FIGURE 1-1

Unfortunately the Canadian Air Transportation Administration is not faced with a single requirement, but rather with a multitude of requirements which in turn generate a large number of generally complex, and always interrelated, projects.

There are three significant factors which further complicate the situation. First is the fact that each of the projects identified must relate in some unique way to the existing operational system; second, each of the projects is in a different state of completion, and third, project outputs must be implemented into an operating system without causing a functional loss of service.

To address this, a unique approach to System Engineering planning is proposed. This approach was developed specifically for the U.S. National Airspace System Plan and has been adapted to the Canadian Airspace System Plan. The proposed scheme involves a four tiered approach to identifying Operational Service Requirements, identifying Operational Performance Requirements, and developing System Designs that are responsive to those requirements.

This tiered, or layered, approach permits requirements identification activities and system designs to proceed both in series and in parallel. Upon completion of Level I (the most general) definition of Operational Service Requirements, work can begin on Level II, but at the same time Level I of Operational Performance Requirements can be defined which in turn permits Level I of System Design to begin. This scheme proceeds in a "waterfall" fashion until all four design levels have been accomplished. Level I sets out levels of service, functional requirements, and the allocation of these to system components. Level II translates the allocated functional design to a topological description of "what goes where", while Level III describes "what goes where" at selected points in time (to ensure a smooth and efficient transition from the existing system) and Level IV comprises actual site designs. Under this scheme, the overall program design guides project activity. Projects do not proceed independently but are harnessed to an overall program plan.

All four design levels undergo refinement on a concurrent basis as the program evolves. This avoids the time delay that would be incurred with a purely sequential approach, while allowing a mix of top down and bottom up planning. This approach also allows the design to respond to technological advances, as well as changes in requirements and political factors while ensuring that the basic integrity of the design is preserved (i.e. projects accord within an overall program design with the implementations timed to maximize near term benefits while minimizing the need for costly interfaces).

Within each level, levels of service, performance, and design are set out in progressively increasing levels of detail. This enables levels of service and performance definitions to be progressively elaborated as the planning, design, and execution of the Canadian Airspace Systems Plan moves forward.

1.2 MAJOR PROJECT STRUCTURE

Although all the projects in the Canadian Airspace Systems Plan are related, not every project has a direct impact on every other project. It therefore becomes possible to group, or "bundle", the most interrelated and interdependent projects into a series of Major Projects. These are identified as:

- Radar Modernization Project (RAMP [currently approved as a Major Crown Project])
- Microwave Landing System (MLS [currently submitted for approval as a Major Crown Project])
- Flight Data Processing Modernization
- Flight Service Station Modernization
- Control, Performance, and Monitoring Systems
- Communications Control System
- Navigation Systems
- Communication Systems
- Radar and Automation Systems
- Telecommunications Network

- Maintenance
- Development

While it is recognized that each Major Project impacts other Major Projects, and is in turn impacted by them, the suggested breakdown minimizes those impacts by grouping the most interrelated and interdependent projects into each Major Project where the dependencies can be handled within a Major Project rather than in a global context which would be infinitely more complex. This "bundling" permits a number of other actions. It permits a hierarchical structuring of the work and assignment of responsibility, based on the work itself, rather than on an organizational hierarchy. Additionally, it can provide the basis for upgrading the Canadian Airspace Systems Plan from a planning document to a programming document by obtaining a single Project Approval Document for each Major Project.

As an approved programming document, the Plan would serve as the control vehicle for development of the Multi-Year Operations Plan and the Main Estimates. Likewise, projects should then not be included on the Current Year Priority List unless included in the approved program.

1.3 PROGRAM MANAGEMENT HIERARCHY

What is recommended is a program hierarchy (made possible by the "bundling" of individual projects into Major Projects) where the entire Canadian Airspace Systems Plan is defined as The Program with an individual (appropriately supported by staff) assigned the responsibility for accomplishment of the entire Program.

This will involve planning, organizing, directing, coordinating, and reviewing the various Major Projects which when taken collectively constitute the Canadian Airspace Systems Plan. At the next level we have Major Project Managers who do precisely the same things with respect to the individual projects which constitute the Major Project. At the next level we find the Project Engineers who again do precisely the same things with respect to the various activities which when taken collectively constitute a project. These relationships are shown in the following Figure 1-2.

PROGRAM MANAGEMENT HIERARCHY

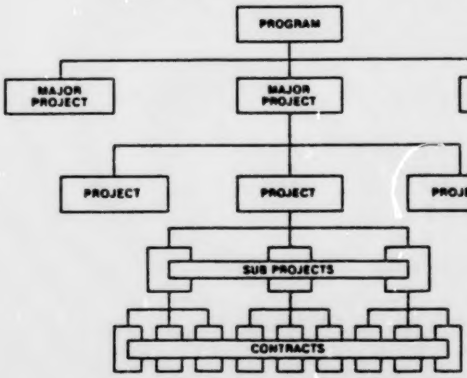


FIGURE 1—2

It is envisioned that each Project Engineer would operate independently of all other Project Engineers, and each Major Project Manager would operate independently of each other Major Project Manager so long as a carefully predefined set of conditions (e.g. cost, schedule) and boundary values (e.g. inputs, outputs) were not impacted. These conditions and boundary values result from the System Engineering activity which resides in the Office of the Program Manager.

1.4 PROGRAM AND PROJECT MANAGEMENT SUPPORT TOOLS

A range of support tools are required to support planning, execution, and management of the implementation of the Canadian Airspace Systems Plan. Specifically, the tools are required in support of Schedule, Cost Control, and resource allocation; Configuration Control; Life Cycle Costing; Program Risk Management of which subsets are cost, schedule, risk analysis, and cost/benefits risk analysis; and Benefit and Benefit-Cost Assurance. Of course these software tools must be supported with appropriate hardware. In addition to acknowledging that there is an immediate and a long term requirement for these tools, the following considerations guided the recommendations presented here:

- o Support tools must be simple to understand and use
- o The tools should explicitely recognize and complement the Program, Major Project, Project, and Subproject/contractual hierarchy
- o The tools must not require a high standard of computer literacy, nor must they rely on the services of a highly qualified functional staff group
- o There must be an immediate as well as a long-term requirement for the tool(s).

1.4.1 HARDWARE

A loosely coupled network of personal computers is recommended for support of the package of program management tools. Suggestions are:

- o IBM PC(XT) with monochrome display
- o Epsom FX100 160CPS Dot Matrix Printer
- o Hayes Smartmodem, 1200 BPS Auto Answer Modem
- o Plotter HP7475

The number of work stations required will depend primarily on the proximity of managers. Where managers share adjoining premises each work station should easily serve up to four managers. Managers at remote sites should be given access to their own work station on site.

1.4.2 SCHEDULE, COST CONTROL, AND ALLOCATION

Inasmuch as schedule, cost control, and allocation are closely linked they have been dealt with together. The software recommended to support these activities are as follows:

- Primavera Project Planner (including Primavision)
- PC-DOS Operating System
- Smartcom II
- Basic Compiler
- Lotus 1-2-3

1.4.3 CONFIGURATION MANAGEMENT

The software packages recommended to support configuration control are the CAE Maintenance Management System developed by CAE, Ltd. of Montreal, Quebec and "CCC" a product of Softool Corporation of Goleta, California.

The package recommended to support hardware configuration control is "COPICS" available from IBM Corporation.

1.4.4 LIFE CYCLE COSTING

The RCA Price H (for estimating hardware costs) and RCA Price S (for estimating software costs) systems appear well suited to meeting the Canadian Air Transportation Administration's requirements for estimating the development and production costs for hardware and software. No off-the-shelf support tool, adaptable to Canadian Air Transportation Administration practices, exists for operations and logistic support costing. The Canadian Air Transportation Administration will need to embark on a specifically designed software package to achieve a full Life Cycle Costing capability. The cost and feasibility of such an activity should be reviewed very carefully in light of the currently underway U.S. Federal Aviation Administration activity addressing the same situation.

1.4.5 PROGRAM RISK MANAGEMENT

For a cost-schedule risk analysis tool PROMAP V is recommended. It is available from Log/An, Inc., 924 Westwood Boulevard, Suite 730, Los Angeles, California. This tool has been used previously used by the Canadian Air Transportation Administration.

The recommended tool to support the Cost-Benefit Risk Analysis activity is CBPACK developed by the World Bank.

1.4.6 BENEFIT AND BENEFIT-COST ASSURANCE

There is no truly adequate general purpose software available to support this activity. Therefore, the recommendation is to periodically update the Canadian Air Transportation Administration's Economic Analysis and Evaluation Division (DAPE) prepared cost benefits analysis incorporating current benefit assurance and cost data as well as any revised planning parameters and assumptions provided by the Project Manager; convert the updated benefit-cost analysis into revised benefit and cost streams; feed these appropriately coded cost and benefit streams into CBPACK which will yield revised cost-benefit indicators and sensitivity analyses for the Project or Program Manager's use.

1.5 PROGRAM IMPLEMENTATION REQUIRED ACTIONS

The Canadian Airspace Systems Plan is easily the most far reaching and complex activity ever embraced by the Canadian Air Transportation Administration. The work envisioned is almost overwhelming. Yet it is a job which must be done. Prudence dictates that implementation be completed in a reasonable length of time and with the least possible impact on the Canadian Treasury. It is with those thoughts in mind that the following required actions were identified.

1.5.1. The requirements identified in the Canadian Airspace Review and elsewhere, both inside and outside the Canadian Air Transportation Administration, must be integrated into the Canadian Airspace Systems Plan.

1.5.2. The Canadian Airspace Systems Plan must be upgraded from a planning document to a programming document to assure an appropriate level of discipline for the introduction of changes to it. The process described in 1.5.4 must become the vehicle by which changes are introduced into the Canadian Airspace Systems Plan. The Canadian Airspace Systems Plan must be reissued periodically.

1.5.3. A much greater organizational participation in future updates of the Canadian Airspace Systems Plan is recommended. At a minimum, representatives of the Air Navigation Requirements Branch and the Air Traffic Services Branch, together with some of their Regional counterparts, must participate in these updates.

1.5.4. The Canadian Airspace Systems Plan must be upgraded from a planning document to a programming document where it would then serve as the control vehicle for development of the Multi-Year Operations Plan, the Main Estimates, and the Current Year Priority List. This could be done by "bundling" like and interdependent projects into a number of Major Projects and obtaining approval of a single Project Approval Document for each Major Project.

1.5.5. "Bundling" of the projects as described in 1.5.4 will permit a hierarchical structuring of the work and clear assignment of responsibility for its accomplishment based on the work itself rather than on the basis of an organizational hierarchy. This must be done.

1.5.6. The definition of Operational Service Requirements and Operational Performance Requirements, as well as the System Designs, must be folded together so that they can operate in parallel as previously described.

1.5.7. Some care has been taken to avoid suggesting how the engineering organization should be organized. It is far too emotional an issue and generally results in little more than extended discussions and hard feelings. None the less, it is implicit in all the foregoing discussion that a System Engineering organization must be established, and such is the case. A System Engineering organization must be established and it must be located in the office of the overall Program Manager. Responsibilities should include, among other things, overseeing the various levels of design, assuring integration within and between Major Projects and recommending appropriate tradeoffs to assure that the total program remains in balance, on schedule, within allocated funding levels, and produces the desired (promised) benefits.

1.5.8. Decisions need to be made promptly as to the tools which will be used in support of program management and these tools, both hardware and software, must be acquired and implemented in the immediate future.

1.5.9. The resources required to keep the Canadian Airspace System Plan current, assure program integration, and to implement the individual projects must be accommodated. Those resource needs are identified in the following section.

1.5.10. The continuing impact of identifying requirements, planning, and implementing the Canadian Airspace Systems Plan on Offices of Collateral Interest (particularly the Air Traffic Services Branch) must be acknowledged and resources required to accommodate that impact must be provided.

1.6 PERSON YEAR RESOURCE REQUIREMENTS

As should well be expected, the person years of effort estimated as being required to implement this new and greatly expanded capital program significantly exceed those which are currently available. The most prudent manner of accommodating this shortfall is judged to be a combination of; 1) increasing the basic staff to the A-Base level recommended in the recently completed Ministry of Transport sponsored A-Base review; 2) supplementing that basic staff with additional capital person years in recognition of the nature of this program (i.e. it is a capital program with a beginning and an end); and 3) supplementing those government workforces with a System Engineering and integration support type contractor obtained through competitive procurement. At the maximum this contractor support would represent slightly more than 20% of the technical/engineering workforce.

A realistic judgement as to when actual employment levels (both Government and System Engineering and integration support type contract employees) can be achieved indicate a technical/engineering person year shortfall which during the first 1-2 years of the Program must be accommodated in an imaginative manner if the Program is to be kept moving at an acceptable pace until the appropriate levels of Government employees and a System Engineering and integration support type contractor can be retained and begin to provide support. Suggested is a combination of seconding Regional personnel to Headquarters and the negotiation for some short-term contractual support with a contractor well versed in System Engineering and in Canadian Air Transportation Administration operations.

CHAPTER 2

SYSTEM ENGINEERING PROCESS

2.0 SYSTEM ENGINEERING PROCESS

2.1 INTRODUCTION

The Canadian Airspace Systems Plan and the Capital Investment Plan describe an extremely large technical framework of activities. When the results of the Canadian Airspace Review, levels of Operational Service Requirements determinations, and formal Operational Performance Requirements definition are superimposed on, or integrated into, those plans the framework of activities becomes so large and complex that they must be addressed in a System Engineering context. Otherwise there is virtually no hope of successfully implementing those plans in any reasonable time frame and at any reasonable cost.

This section is a generalized description of the System Engineering process and its application to planning and implementation of the Canadian Airspace Systems Plan.

2.2 GENERAL DESCRIPTION - SYSTEM ENGINEERING PROCESS

A block diagram of a Systems Engineering Process is depicted in Figure 2-1. For purposes of discussion, it has been divided into five activities; Planning, Budgeting, Project Design and Production, System Implementation, and Operations and Maintenance. In a literal sense, budgeting is not a part of the System Engineering process. It is, however, addressed in the diagram in acknowledgement of the stark reality that without resources there can be no Program and no implementation. In as much as the focus of this paper is the Canadian Air Transportation Administration's Capital Program, Operations and Maintenance will not be discussed.

SYSTEM ENGINEERING PROCESS

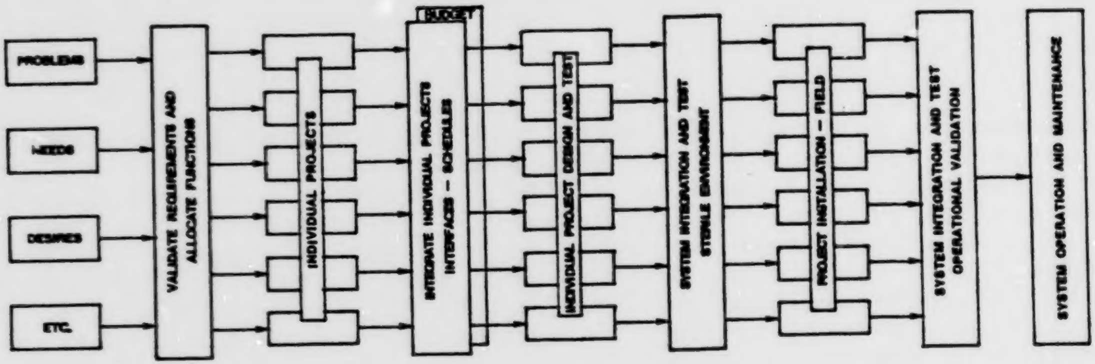

PROBLEMS
NEEDS
DESIRES
ETC.
VALIDATE REQUIREMENTS AND ALLOCATE FUNCTIONS
INDIVIDUAL PROJECTS
BUDGET
INTEGRATE INDIVIDUAL PROJECTS INTERFACES - SCHEDULES
INDIVIDUAL PROJECT DESIGN AND TEST
SYSTEM INTEGRATION AND TEST STERILE ENVIRONMENT
PROJECT INSTALLATION - FIELD
SYSTEM INTEGRATION AND TEST OPERATIONAL VALIDATION
SYSTEM OPERATION AND MAINTENANCE

FIGURE 2-1

The process begins with the identification of problems, needs, desires, etc. The source of these imputs can be from anywhere - external review authorities, internal management, system users, employees, etc.

In the first step, these problems, needs, etc. are analyzed and either validated or not validated as a requirement. As an adjunct to the validation process, a functional allocation process begins. That is to say that conscious decisions are made about how to handle each validated requirement (e.g. capital, non-capital, procedural, regulatory, etc.). The functional allocation, then, results in a series of projects or activities each designed to accommodate a specific requirement or series of requirements. The specific projects or activities are then considered as a set to insure that when they are taken together they fully address the validated requirements without overlaps or gaps and that they represent the smallest set of facilities or systems which will satisfy the requirements.

The result of that analysis provides the basis for seeking funding. The budget is the vehicle by which funds are obtained in furtherance of Government, Department, Administration policies and/or goals. It is a pricing of specifically articulated plans and programs which upon approval provides the basis for the distribution of resources. Most importantly it provides the basis for measuring physical versus fiscal program performance and accomplishment.

Upon approval of the budget and delegation of funds Project Design and Production begin.

Project Design and Production in a System Engineering context are little different than in a non-System Engineering context. The only difference worth mentioning is that generally interface constraints have been levied on the project during the planning and programming activity.

Upon completion on Project Design and Production, System Implementation begins.

System Implementation starts with the integration of the various project and activity outputs - usually in a sterile environment. The need for this integration is a function of the interaction between projects, their complexity, and the implications of an unsuccessful initial integration effort in an operating environment. Following successful integration in the sterile environment, each product is installed in the field, integrated with other project outputs, and tested in the field operating environment to insure that the individual projects will operate as a system.

Upon satisfactory completion of that testing, the final product is put into service for Operations and Maintenance.

We will now discuss each of the generalized System Engineering activities in terms of the Canadian Air Transportation Administration's application of them to the planning and implementation of the Canadian Airspace Systems Plan.

2.3 SYSTEM ENGINEERING IN THE CANADIAN AIR TRANSPORTATION ADMINISTRATION

The previous section provided a general description of the System Engineering process. This section will describe how that process has been applied in the Canadian Air Transportation Administration.

2.3.1 PLANNING (Figure 2-2)

The planning process existing in the Canadian Air Transportation Administration is well structured and rather thoroughly documented. At the heart of the process is the Government-wide Policy and Expenditure Management System which helps to ensure that policy and program decisions are made in the context of cost and expenditure limitations. It further helps ensure that planning decisions are made with an understanding of the National Government's policies and priorities.

Within this framework transportation strategies, objectives, policies, and programs are developed and ultimately amplified into a Strategic Overview for aviation.

The Strategic Overview, overlaid by the Canadian Air Transportation Administration's Management Guidelines, which provide the direction for Canadian Air Transportation Administration activities, provides a sound basis for the development of specific action plans and programs. Among these are the Capital Investment Plan and the Canadian Airspace Systems Plan. What we find then are Administration plans clearly articulated and approved by top level management. Not only do these plans provide the basis for the Multi-Year Operations Plan and Main Estimates, they are also traceable through transportation plans to National policies and guidelines. The orientation of the Canadian Air Transportation Administration's plans is what will be achieved by implementing the plans, that is, what will be achieved in terms of contributions to a set of specific goals and objectives which support the Canadian Air Transportation Administration's mission and, ultimately, National priorities.

In the normal way development of Canadian Air Transportation Administration plans will begin with definition of appropriate levels of service. This would include (1) development of a set of standards against which user demands would be measured in order to validate (or not validate) them as legitimate Canadian Air Transportation Administration requirements; (2) allocation of those requirements between ground and air, and; (3) development of standards or criteria for the provision of a service (such as landing systems, Air Traffic Control towers, radars, enroute navigation systems, etc.).

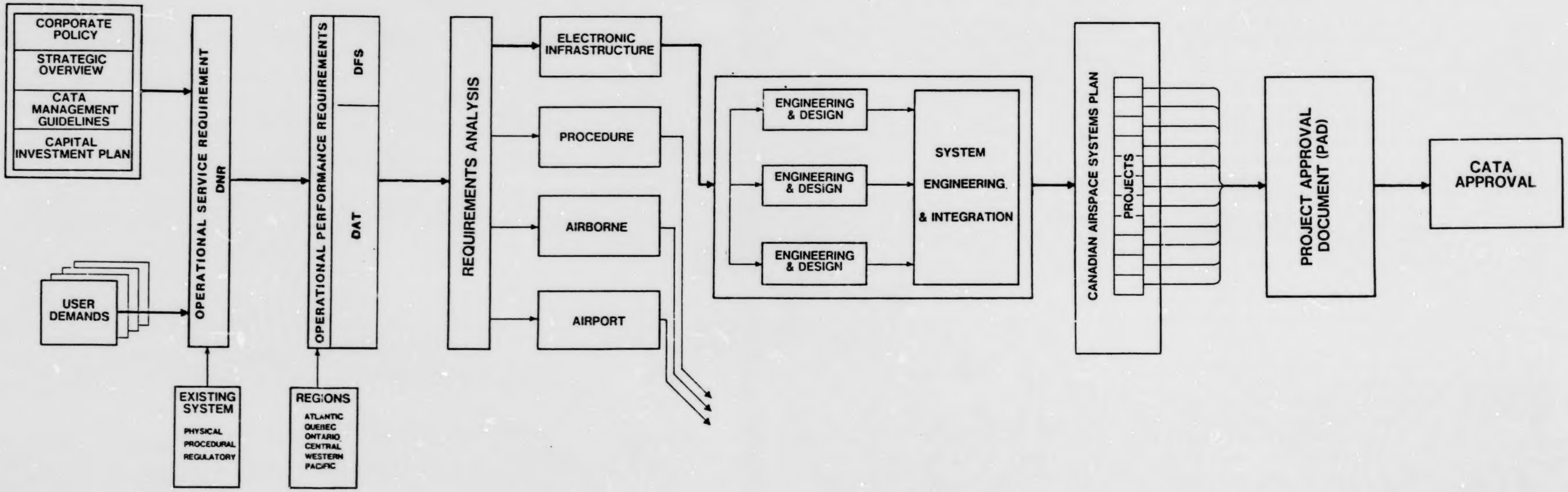

CORPORATE POLICY
STRATEGIC OVERVIEW
CATA MANAGEMENT GUIDELINES
CAPITAL INVESTMENT PLAN
USER DEMANDS
OPERATIONAL SERVICE REQUIREMENT
DNR
EXISTING SYSTEM
PHYSICAL
PROCEDURAL
REGULATORY
OPERATIONAL PERFORMANCE REQUIREMENTS
DFS
DAT
REGIONS
ATLANTIC
QUEBEC
ONTARIO
CENTRAL
WESTERN
PACIFIC
REQUIREMENTS ANALYSIS
ELECTRONIC INFRASTRUCTURE
PROCEDURE
AIRBORNE
AIRPORT
ENGINEERING & DESIGN
ENGINEERING & DESIGN
ENGINEERING & DESIGN
SYSTEM ENGINEERING & INTEGRATION
CANADIAN AIRSPACE SYSTEMS PLAN
PROJECTS
PROJECT APPROVAL DOCUMENT (PAD)
CATA APPROVAL

FIGURE 2—2

Once the levels of Operational Service Requirements have been identified and defined, the Operational Performance Requirements can be articulated. This would begin with a description of the various functions and the allocation of those functions between the person and the machine. That determination would then lead to a description of how to satisfy the functional allocation in terms of those facilities whose locations are fixed by function (e.g. Instrument Landing Systems, Air Traffic Control Towers) and those facilities whose locations are based on volumetric considerations (e.g. communications, navigation, and surveillance).

It is only after the Operational Performance Requirements have begun to be articulated that the System Design may begin. This will involve the functional allocation of Operational Performance Requirements between various facility and equipment types. The constraints imposed by the existing system and the existing topology will have a significant impact on the allocation of those requirements and the necessary interfaces. Projects must first be considered individually and then as a set.

Considering the individual projects in aggregate is one thing which sets System Engineering planning apart from traditional project engineering. It is here where a careful analysis of the interactions between facilities and systems allows the smallest set of facilities and/or systems which will satisfy the total operation requirement to be defined. This is an activity which the Canadian Air Transportation Administration has not been formally involed to any great extent. The reason, of course, being that the Canadian Air Transportation Administration has never been faced with a program of the magnitude or complexity envisioned by the Canadian Airspace Systems Plan.

The foregoing progression of activities would seem to be accommodated rather gracefully within the existing organizational structure of the Assistant Administrator for Air Navigation. The responsibility for identification and definition of Operational Service Requirements falls rather clearly within the purview of the Air Navigation Requirements Branch. The responsibility for articulating the Operational Performance Requirements falls within the purview of the Air Traffic Services Branch and the responsibility for System Designs, including System Engineering planning and design integration, lies clearly with the Facilities Engineering and Systems Development Branch. It must be recognized that in some few instances the Facilities Engineering and Systems Development Branch will generate Operational Performance Requirements. Those requirements will be directly related to and in support of the maintenance activity for which they are responsible. Those few instances not withstanding, the Air Traffic Services branch is clearly the organization with the primary and major responsibility for identifying Operational Performance Requirements.

The programming process with regard to capital projects, at first glance, appears cumbersome and unwieldly. Closer scrutiny, however, does not necessarily support that contention, although one could argue that the volume of paper involved is excessive. The process for identifying and documenting requirements and developing projects to satisfy those requirements is well documented and reasonably straight-forward. The principal documents in the process are the Approval in Principle Document and the Project Approval Document. The former is primarily intended to make management aware of new proposals in terms of financial impact and time, major implications and risks, and the policies and objectives which the proposal supports. The latter is an application for approval of the introduction of a project into the Multi-Year Operations Plan and Main Estimates and for consideration for funding the project.

Approval of the Approval in Principle Document constitutes authority to commit effort to fully develop the proposal including detailed work plans. Approval of the Project Approval Document means that a firm allocation of resources is to be sought. This system for documenting proposals, whether in the form of an Approval in Principal Document or Project Approval Document, is well accepted and understood and there is no reason to propose any conceptual changes to it.

2.3.2 BUDGETING (Figure 2-3)

Conceptually, a budget management system should integrate top level agency planning, budgeting, and fiscal program management into a cohesive, well defined process understood and accepted by all levels of supervision and management. Such is generally the case in the Canadian Air Transportation Administration.

In the formulation phase of the budget, Administration plans clearly articulated and approved by top level management must "drive" the budget. The Canadian Airspace Systems Plan has the potential for becoming that "driver", but, before that can happen, it must be broadened in its perspective to clearly reflect levels of service determinations and specifically stated Operational Performance Requirements. This is in no way intended to denigrate the existing Plan. It is an extremely well done, credible document. The orientation of the Plan is on what will be achieved by implementing it. What will be achieved in terms of improved productivity, improved system capacity, and the like, which is as it should be. However, before the Plan can become a programming document the requirements identified in the Canadian Airspace review and elsewhere within and outside the Canadian Air Transportation Administration must be integrated into the Plan. Upon approval of the resulting projects via the Project Approval Document process discussed earlier, the Canadian Airspace Systems Plan will become the programming document which provides the basis for developing budgetary requirements.

The Canadian Airspace Systems Plan has resulted in significant funding increases. As the Canadian Airspace Review matures there will be an even greater demand for funding. As aviation begins to consume an increasing share of transportation funding it will become increasingly important to be able to quantify and document the benefits realized from each completed project or program. Failure to do so will inevitably result in funding at only the A-Base level.

As projects become larger, more complex, and interdependent, the need for management officials responsible for mission accomplishment to operate in accordance with National policies, programs, standards, procedures, and resource allocations becomes increasingly important to success. Performance reviews addressing physical versus fiscal performance must be a continuing activity at all levels of supervision and management.

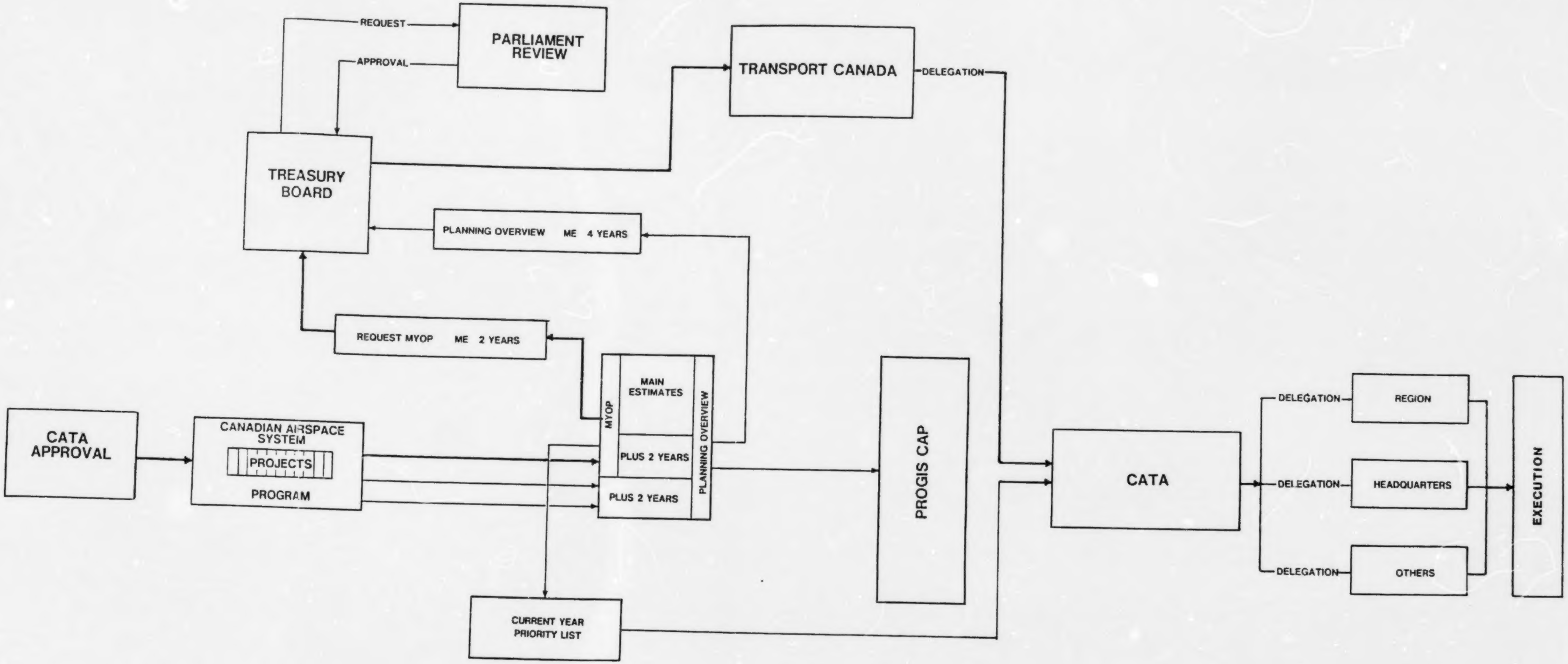

REQUEST
PARLIAMENT REVIEW
APPROVAL
TRANSPORT CANADA
DELEGATION
TREASURY BOARD
PLANNING OVERVIEW ME 4 YEARS
REQUEST MYOP ME 2 YEARS
MAIN ESTIMATES
MYOP
PLUS 2 YEARS
PLUS 2 YEARS
PLANNING OVERVIEW
CATA APPROVAL
CANADIAN AIRSPACE SYSTEM
PROJECTS
PROGRAM
PROGIS CAP
CATA
DELEGATION
REGION
DELEGATION
HEADQUARTERS
DELEGATION
OTHERS
EXECUTION
CURRENT YEAR PRIORITY LIST

FIGURE 2–3

2.3.3 PROJECT DESIGN AND PRODUCTION (Figure 2-4)

Upon approval of funding the projects and activities previously identified proceed into individual project design and production. In the Canadian Air Transporatation Administration this typically involves the development of a prototype specification which results in a contract for development of prototype equipment or software. The output of the prototype development is normally a production specification which eventually leads to a contract for volume production.

It is during this phase of activity that quality control activities become apparent - as they should. Attention is paid to the quality of specifications, compliance with those specifications, and the work and workmanship involved in the installation of equipment. Project and program scheduling and accomplishment are carefully monitored and controlled to insure that implemenation is in accordance with plans. Benefits expected to materialize as the result of implementing the program and/or project must be monitored and validated. That is to say that when projects or programs justified on the basis of improved efficiency, or system capacity, or the like, are funded and the work accomplished, the resulting benefits must be measured and compared to the benefits projected when the project or program was justified.

Upon satisfactory completion of testing the resulting product, to insure that it performs as designed, it is ready for deployment. In the case of a single requirement and single project to satisfy that requirement, deployment would involve field installation and operational testing to insure that the product in addition to satisfying design requirements also satisfies the operational requirement which was the genesis of the project. Unfortunately, in a complex environment there is almost never a single requirement or a single project to satisfy that requirement. This is the situation in which the Canadian Air Transportation Administration finds itself with respect to the Canadian Airspace Systems Plan. There are numerous projects or activities required to satisfy numerous requirements. In a System Engineering context the existence of multiple projects or activities leads to the need for integrating the outputs of the several projects prior to deploying them to the field. We have chosen to call this activity System Implementation, an activity with which the Canadian Air Transportation Administration has not had to concern itself with a great deal in the past because it has never been faced with a program of this magnitude or complexity.

PROJECT DESIGN AND PRODUCTION

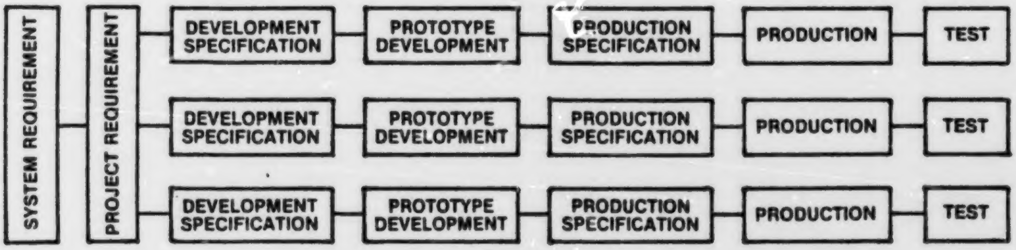

SYSTEM REQUIREMENT
PROJECT REQUIREMENT
DEVELOPMENT SPECIFICATION
PROTOTYPE DEVELOPMENT
PRODUCTION SPECIFICATION
PRODUCTION
TEST
DEVELOPMENT SPECIFICATION
PROTOTYPE DEVELOPMENT
PRODUCTION SPECIFICATION
PRODUCTION
TEST
DEVELOPMENT SPECIFICATION
PROTOTYPE DEVELOPMENT
PRODUCTION SPECIFICATION
PRODUCTION
TEST

FIGURE 2—4

2.3.4 SYSTEM IMPLEMENTATION (Figure 2-5)

In the planning activity discussed earlier, validated requirements were addressed individually and then as a set. The result of that activity was the identification of a series of projects which satisfied not only the individual requirements but also the set of requirements - a system plan. And so it is that individual project outputs cannot be deployed without first assuring that in addition to operating individually (as was done in the Design and Production activity) they will operate with the others and that combined they will work as a system. The first step of System Implementation, then, is integration of the various project outputs. This involves merging the outputs of interdependent projects into a single integrated operating system to validate (verify) that the individual products will indeed operate as a system and satisfy system requirements. This integration activity may be carried out in the field operating environment or in a sterile (i.e. non-operational) environment. Generally the more complex and interrelated the individual products are the more desirable it is to perform the integration activity in a sterile environment. It may not always be possible, but it is almost always desirable. One side benefit of performing the integration in a sterile environment is that it allows initial training in system operations. There are other benefits.

Having satisfactorily completed system integration and testing, each project is then ready for field installation and integration, and operational testing. Operational testing confirms that the integrated system operates in a field environment and that the delivered system satisfies the originally articulated requirement(s). The system is then placed into service for operations and maintenance.

The Canadian Air Transportation Administration has never been faced with a program anywhere near as large as that envisioned by the Canadian Airspace Systems Plan. Therefore, there has never really been a need to become deeply involved in a systems integration or systems level operational testing. Such is no longer the case.

SYSTEM IMPLEMENTATION

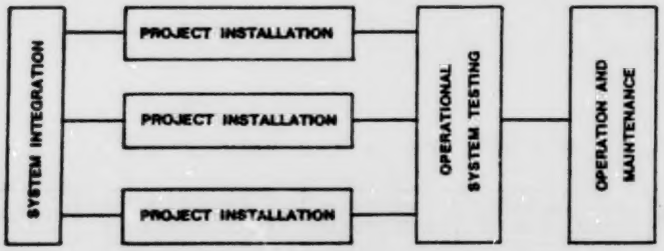


FIGURE 2—5

2.4 OBSERVATIONS AND CONCERNS

In the previous section we reviewed the application of System Engineering processes to the Canadian Air Transportation Administration's planning and implementation of the Canadian Airspace Systems Plan. The result of that review is the identification of a number of observations and concerns which must be accommodated if the activity is to be a success. This section describes those observations and concerns.

2.4.1 OBSERVATIONS

2.4.1.1. The Canadian Airspace Systems Plan represents the first effort to integrate all Canadian Air Transportation Administration requirements into a single program. Obviously a great deal of thought and effort have gone into preparation of the Canadian Airspace Systems Plan. The result is a very credible document. Yet it may be less than fully comprehensive because of the lack of broad-based organizational representation in its development. In some cases projects have been included based solely on inferred requirements, in other cases they are included based on empirically derived requirements, and in yet other cases projects are included based on institutionalized requirements. Each of these can be a valid basis for creating a project, however, they are an insufficient basis for defining a Canadian Airspace Systems Plan embraced by all.

2.4.1.2. Generally the planning, programming, and budgeting processes extant in the Canadian Air Transportation Administration are not overly cumbersome. There is, however, a great deal of paperwork associated with development and approval of Project Approval Documents. The amount of paperwork is a function of the large number of individual projects as well as the need for an almost equal number of Regional Project Approval Documents in support of virtually all headquarters generated Project Approval Documents.

2.4.1.3. The Canadian Airspace Systems Plan is treated as a planning document rather than as a programming document. As a programming document it would provide the sole basis on which projects could be included in the Main Estimates or the Multi-Year Operational Plan. (i.e. a project would have to be included in the approved program before it could be included in the budget).

2.4.1.4. The Canadian Air Transportation Administration has begun to move in the direction of System Engineering as exemplified by the combining of some small projects into Major Crown Projects. Even so the system orientation remains fairly narrow. The total system requirements are not being addressed as a unity. Projects, even Major Crown Projects, are being addressed discretely rather than as a part of an overall program.

2.4.1.5. Planning and design of the system are not being accomplished in a global context. Planning and design of the entire system all at one time are not happening.

2.4.2 CONCERNS

While it is entirely appropriate to lay the System Engineering groundwork for program accomplishment in a static environment, it would not be appropriate to suggest any actions without taking the real world into consideration. This section describes the real world concerns which must be accommodated in developing a course of action.

2.4.2.1. Functionally the inplace system must continue to operate even as it is being changed. The continued safe and efficient utilization of the Canadian Airspace demands that existing levels of service be preserved even as the system is being modernized or replaced.

2.4.2.2. The system is in a constant state of change and the activities creating that change are each in a different state of completion. Some are being implemented, others are in production, still others are in design, etc. Planning and implementation activities must acknowledge those various states and take them into consideration in outlining what is to be done.

2.4.2.3. The Plan must be sufficiently well supported and complete to withstand attacks by critics, yet it must be flexible enough to accommodate justified changes without a complete upheaval.

2.4.2.4. Ways must be found to collapse the time required to do the System Engineering planning as well as handling the corresponding programming and budgeting activities (e.g. Project Approval Document preparation) without compromising the integrity of the process or activities.

CHAPTER 3

SYSTEM ENGINEERING MANAGEMENT IMPLEMENTATION PLAN

3.0 SYSTEM ENGINEERING MANAGEMENT IMPLEMENTATION PLAN

3.1 INTRODUCTION

The previous section described a generalized System Engineering process, the application of that process to the Canadian Air Transportation Administration, made some observations concerning System Engineering in the Canadian Air Transportation Administration, and described a number of premises which must be accommodated in developing a System Engineering Management Implementation Plan.

This section outlines a series of activities and processes required to insure cohesive planning and implementation of the Canadian Airspace Systems Plan. It is in effect the System Engineering Management Implementation Plan.

3.2 INTEGRATED SYSTEM ENGINEERING PLANNING

The just described institutional planning framework existing in the Canadian Air Transportation Administration is a rational one and has served the Administration and the Canadian people well.

It begins with identification of Levels of Operational Service Requirements which then permits Operational Performance Requirements to be defined which in turn provides the basis for System Design. As stated, there is no need to change that framework. However, the Canadian Airspace Systems Plan and the Capital Investment Plan describe a set of activities so far-reaching and complex that there is a need to alter the manner in which people operate within the institutional framework. This need is further buttressed by considerations of time and cost, which in an activity as large and complex as the Canadian Airspace Systems Plan become very important considerations. When they do, planning can no longer proceed completely through a fully detailed levels of Operational Service Requirements determination before Operational Performance Requirements can begin to be defined. By the same token, Operational Performance Requirements cannot be described to the detail of the individual facility before System Designs can start. Levels of Operational Service Requirements, Operational Performance Requirements, and System Designs must be folded together so that they can proceed in parallel.

The unique approach depicted on Figure 3-1 was originally developed for the U.S. National Airspace System Plan and has been adapted to the Canadian Airspace Systems Plan. The scheme involves a four tiered approach to identifying Operational Service Requirements, identifying Operational Performance Requirements, and developing the System Designs responsive to those requirements.

INTEGRATED SYSTEM ENGINEERING

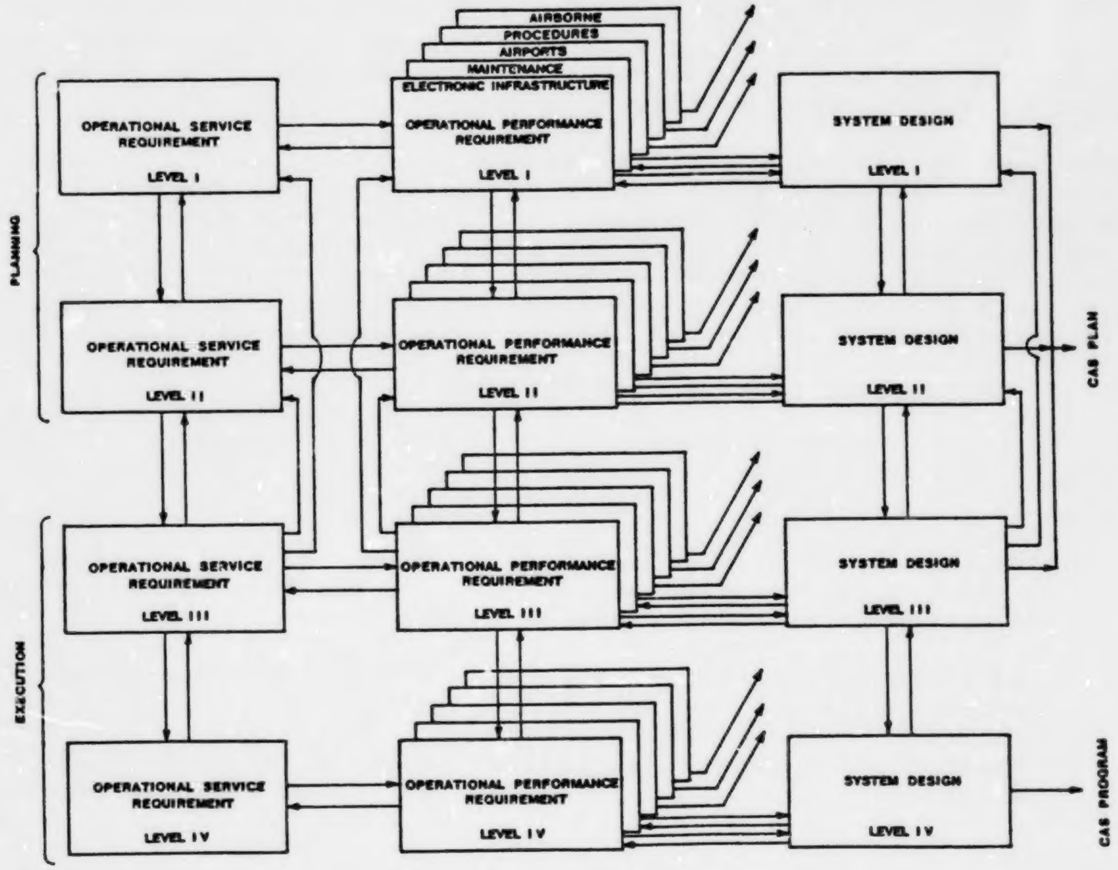

AIRBORNE
PROCEDURES
AIRPORTS
MAINTENANCE
ELECTRONIC INFRASTRUCTURE
PLANNING
EXECUTION
OPERATIONAL SERVICE REQUIREMENT LEVEL I
OPERATIONAL PERFORMANCE REQUIREMENT LEVEL I
SYSTEM DESIGN LEVEL I
OPERATIONAL SERVICE REQUIREMENT LEVEL II
OPERATIONAL PERFORMANCE REQUIREMENT LEVEL II
SYSTEM DESIGN LEVEL II
CAS PLAN
OPERATIONAL SERVICE REQUIREMENT LEVEL III
OPERATIONAL PERFORMANCE REQUIREMENT LEVEL III
SYSTEM DESIGN LEVEL III
OPERATIONAL SERVICE REQUIREMENT LEVEL IV
OPERATIONAL PERFORMANCE REQUIREMENT LEVEL IV
SYSTEM DESIGN LEVEL IV
CAS PROGRAM

FIGURE 3—1

Operational Service Requirements, Operational Performance Requirements, and System Designs are each divided into four levels of activity - proceeding from the most general (Level I) to the most detailed (Level IV) for each class of activity. Within each class of activity, determinations must be weighed against a set of standards which address as a minimum, aviation safety, continuity of service, user benefits and costs, cost of Government, aviation activity, socio-economic implications, and industrial implications. The thing which makes this approach unique is that it allows Operational Service Requirements determinations, Operational Performance Requirements and the supporting System Design to proceed in parallel.

As an aid to facilitate understanding the interactions between the three classes of activity and the four levels of output, we will describe the types of things being addressed in each.

This description is intended to express a concept and it must be recognized as such. There is not necessarily a one for one correspondence between each level of output in each class of activity. When a particular level of output is not germaine to a particular situation, it should be passed over. Additionally, the examples indicated are just that -- examples. They should not be considered as all encompassing, nor should they be considered as limiting.

3.2.1 OPERATIONAL SERVICE REQUIREMENTS:

DESCRIPTION	EXAMPLE
Level I	
o Validation of user demands as Canadian Air Transportation Administration requirements.	Needs, desires, probems, weighed against policies and standards.
o Determine allocation of requirements.	A regulation versus a capital project.
o Further allocation of capital solutions.	Aircraft equipage versus ground equipment -- or a combination of the two.
o Development of standards or criteria for the provision of a service.	Facility criteria such as for landing systems, Air Traffic Control Towers, radars, enroute navigation systems, etc.

Level II

o Determination of the performance requirement.	The amount of service to be provided and the accuracy of that service.
o Determination of where that service is to be provided (end state).	Requirements for coverage from volumetric facilities (navigation, communications, surveillance, weather, etc) e.g. navigation capability required to 2,500' above ground level for first 100KM north of the Canadian/U.S. border. Tower service required at some particular location.

Level III

o Transition - Determination of how to transition from the levels of service currently being provided to the levels of service envisioned in Level II and in what time frame.	Time frame in which the tower service at the location indicated in Level II is to be provided. Time frame in which navigation capability is required to 5,000' above ground level and then to 2,500' above ground level.

Level IV

o Description of the levels of service by site.	The identification of the required ground facilities on Area and Site Master Plans.

3.2.2 OPERATIONAL PERFORMANCE REQUIREMENTS:

Level I

o Description of the various functions to be performed on the ground and their allocation between man and machine.	Approach Control: Manual approach control versus radar approach control.
o Description of the interfaces between person/person, person/machine, machine/machine.	For radar approach: The type of display (light room or dark room); where located, e.g. Tower Cab or Area Control Center?

o Determination of the inputs and outputs for each interface.	For Radar Display: With or without alpha-numerics?; with alpha-numerics, what is to be displayed (e.g. aircraft identification, speed, altitude, etc.).
Level II	
o Determination of how to satisfy the functional allocation (i.e. distribution of facilities).	Manned Facilities: Sector descriptions Number of Sectors Locations Numbers and types of people. Volumetric Facilities (to the extent they are required to support Air Traffic Control functions): Navigation Communications Surveillance Weather
Level III	
o Transition - Determination of how to transition from the operational performance currently being provided to that envisioned. Determine what operational performance levels are expected in specified intermediate time frames.	Specific time frames in which the facilities and system identified in Level II should materialize. Identify any procedures, either interim or permanent, which may be required to allow the intermediate performance levels to be realized.
o Development of Standard.	National guidance as to what changed procedures are and how to implement them.
Level IV	
o Adaptation of Standards to individual facilities.	Determination of how National Standards will be adapted to individual facilities.

3.2.3 SYSTEM DESIGNS:

Level I

o Allocation of Operational Performance Requirements between systems and equipment.	Distribution of processing function between a Terminal Control Center and Area Control Center computer (Note: a significant constraint at this point is the status of existing facilities and the status of current procurements).

Level II

o Topology - Determination of the locations of existing facilities their current performance levels, and the changes required to satisfy the Operational Performance Requirements.	Where are existing navigation facilities located and what coverage do they provide? - likewise communications, surveillance, etc. Define the smallest set of facilities and/or systems which will satisfy the Operational Perfomance Requirement and where are they to be physically located to do so.
o Performance requirements	With an allowable two second delay between target detection and display what is the distribution of that time between the Radar, Digitizer, transmission medium, computer, and display?
o Connectivity - Determination of how all the facilities are to be linked together.	Radar data to be provided to a specific Area Control Center and a specific Terminal Control Center.

The result of Level II System Design will be the description of an "end state" system configuration.

Level III

o Definition of interim system configurations leading to the "end state" configuration.	Identify specific time frame in which the facilities and/or systems identified in Level II must materialize in order to to meet the Level III Operational Performance Requirements.
o Analysis of dependencies, risks, and opportunities.	Determination that schedule adjustments on a pair of projects could be changed, thereby eliminating the need for an interim interface (which always costs money). The result of this could well be a recycling to Level III of Operational Performance Requirements for consideration.
o Develop System Test scenarios.	Determine what tests must be run and how they must be accomplished to validate that the various facilities and/or equipment operate as a system and satisfy the Operational Performance Requirement.
o Develop standard (typical) site designs.	Standard radar site and equipment layout. Standard Air Traffic Control Tower design.

Level IV

o Adaptation of standard designs to individual facilities and sites.	Site adaptation of standard designs.
o Development of individual site test scenarios.	Determine what tests must be run at a particular site to validate that the individual site operates as designed and satisfies the stated Operational Performance Requirement for that site.

Dividing each class of activity into four levels allows levels of Operational Service Requirements, Operational Performance Requirements, and System Designs to be folded together so that they can proceed in parallel, thus compressing the time required to accomplish these important activities.

When Operational Service Requirements Level I is complete, activity can begin on Level I of Operational Performance Requirements while Operational Service Requirements activity proceeds to Level II. When those two activities are complete, Level I of System Designs may begin while Operational Service Requirements moves to Level III and Operational Performance Requirements moves to Level II - and so on.

Figure 3-2 depicts the work progression. Each box corresponds with the boxes shown previously in Figure 3-1. Each darkened box represents the progression of activity, and shows how the work can be done in parallel.

PARALLEL PROGRESSION OF ACTIVITY

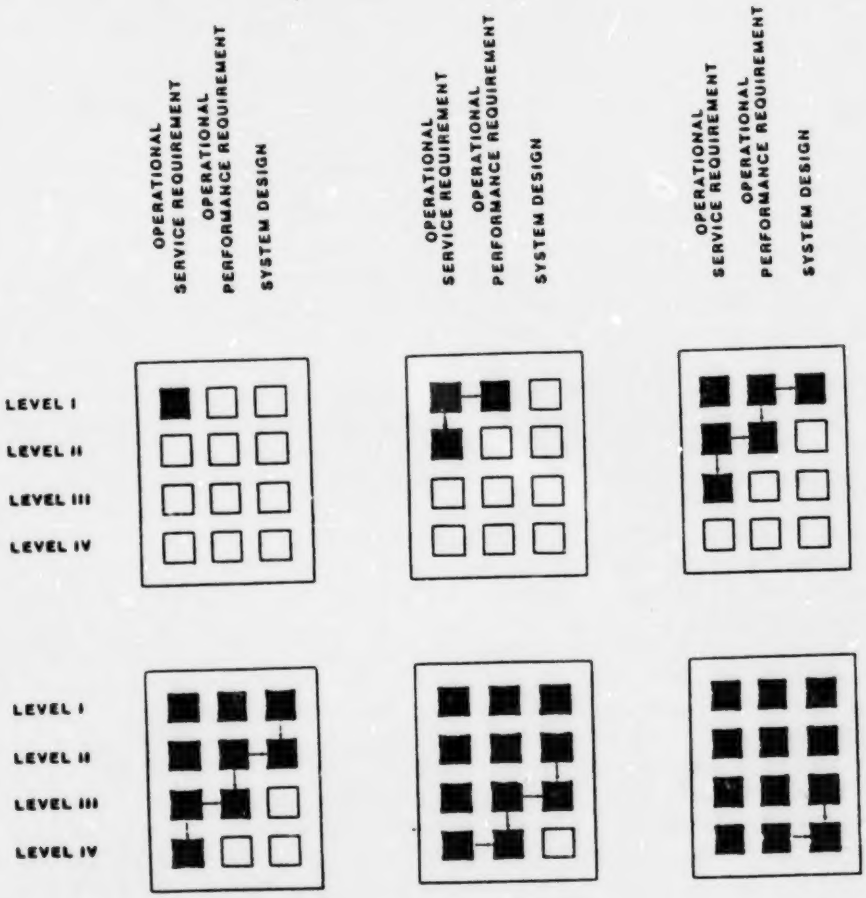

OPERATIONAL SERVICE REQUIREMENT
OPERATIONAL PERFORMANCE REQUIREMENT
SYSTEM DESIGN
LEVEL I
LEVEL II
LEVEL III
LEVEL IV

FIGURE 3—2

In the Systems Engineering Model discussed earlier, there was no indication of the need for Level III type activities. In the model there is no need for such activity. The real world is quite another matter and there are two very real reasons for including Level III activity in the process.

First. In practice we are faced with an existing system which must be kept in operation even as it is being changed. Additionally, we are faced with numerous ongoing projects each in a different state of accomplishment. Some are in the process of installation, others are in production, others are under design, and yet others are only beginning to be thought about. It is almost axiomatic that those activites which are nearest to completion are those which we can change the least (without disrupting the entire activity) and those which are the furthest from compeltion are more susceptible to change (again without disrupting ongoing activities). The former imposes the greatest constraint on functional allocation of requirements and the latter imposes the least constraint. The need to accommodate ongoing activities in the planning process, then, is the reason for Level III acitivites. This is accomplished by identifying how we want the system to look at intermediate points in time. Then, considering the degree of flexibility available in associated projects, as described above, opportunities for interim integration activities and interfaces can be defined and project schedules adjusted accordingly to make the interim interfaces materialize.

The second reason is to begin to realize benefits as early as possible in the life of the project. In the normal way, benefits would be realized when the project is completed which could well be many years into the future. By identifying how the system will look and operate at intermediate points we can then identify and take credit for the resulting incremental benefits.

It is clear that in varying degrees each class of activity and each level of output, although not formally described or institutionalized in Canadian Air Transportation Administration directives, has existed in the Canadian Air Transportation Administration. The proposition described above does not imply, nor should it be inferred, that System Designs should come to a stop because Level I Operational Performance Requirements have not been articulated. Nor should Level I Operational Performance Requirements definition stop while Level I Operational Service Requirements are formalized and articulated. Many basic requirements decisions in all three classes of activity have long since been taken and are institutionalized in the Canadian Air Transportation Administration. Some requirements have been empirically developed and yet others have been inferred, both based on the extensive experience existing among those who have been responsive to Canadian Air Transportation Administration requirements over the years. Therefore, there is no general need to delay any ongoing activities to wait for an output from a precendent class of activity. The past is gone, for better or worse, and it is the future which must be addressed. The more quickly this scheme is implemented the greater will be the control of the future.

3.3 ESTABLISHING MAJOR CANADIAN AIRSPACE SYSTEMS PLAN PROJECTS

3.3.1 GENERAL

The Capital Investment Plan, supported in part by the Canadian Airspace Systems Plan, and soon to be further supported by the results of the Canadian Airspace Review, will result in the demand for significant increases in the annual funding levels for capital projects. The Canadian Airspace Systems Plan identifies requirements for assuring the continued high levels of performance of the electronics infrastructure of the Canadian Airspace System. The Canadian Airspace Review will identify both procedural and operational changes which should be made and which will in turn require additional capital expenditures.

Increased funding levels will mean an increase in the number of projects to be accomplished. While it is recognized that a tenfold increase in funding does not necessarily imply a like increase in the number of projects it does remain clear that the number of projects will increase substantially. It is also fairly clear that a corresponding workload increase in the program planning area (i.e. program proposal, review, and approval process) cannot be tolerated in terms of the person-years of effort which will be associated with it. The same thing could be said of the engineering effort involved in accomplishing projects.

In the program planning area there are two things which can, and should, be done. First the number of individual projects shown in Figure 3-3 should be reduced. This can be accomplished by "bundling" a number of like and interdependent projects into groups of larger projects. Second, the practice of developing a Regional Project Approval Document for each site involved should be discontinued in favor of including all work, both Headquarters and Region, in the original Headquarters developed Project Approval Document.

It is recognized that a Project Approval Document requires a Class B cost estimate and that early on in the life of a project, Class B estimates cannot be developed for the Regional portion of the estimates. Obtaining approval for this change will necessitate some negotiation with the Treasury Board, but it is a change well worth pursuing. One way of approaching the change would be to use average costs (Class D estimates based on historical costs for similar work tempered with engineering judgements) for the Regional work with a later update to Class B estimates when appropriate. Further it would seem reasonable to propose that no further justification would be required so long as in the aggregate the total of all Regional costs did not change the original estimate by more than some specified percentage or dollar level.

One aspect of this proposal which may not be readily apparent, but which cannot be taken lightly, is the impact on Regional autonomy. It will be significant. Combining a number of like or interdependent projects into a single project will, in the implementation phase, result in a greater degree of Headquarters involvement and control over the Regional part of the effort than has traditionally existed. Including the Regional work in the original Project Approval Document will result in a greater degree of Headquarters and Regional interdependencies which could be viewed by some a further incursion into Regional autonomy. That is the price which must be paid if a program of the magnitude envisioned in the Canadian Airspace Systems Plan is to be accomplished in anywhere near the time-frame proposed.

After each of the major projects discussed above have been developed, they must be integrated into a systems program and evaluated against policy guidelines, objectives, and the stark reality of funding limitations. This systems approach will involve examining each of the major projects in terms of its impact on all the other major projects and vice-versa. This is an iterative process of continuing review and adjustment, the result of which is a series of major projects which are consistent within each system and between systems and compatible with and supportive of Canadian Air Transportation Administration goals and objectives. The result of the foregoing effort is the beginning of the first level of system requirements identification and design which in turn will represent a truly comprehensive Canadian Airspace Systems Program.

Even though the Canadian Air Transportation Administration is faced with a significantly greater workload than ever previously experienced, "bundling" like and interdependent projects into a series of large projects should allow the program planning activity to function without a corresponding increase in the level of person years required to perform that activity. The same thing could be said with regard to the person year levels required for the associated engineering effort.

However, in the case of the engineering activity the importance of "bundling" far transcends concerns over person years of effort. Of overriding concern in the engineering area is the ability, in a business as usual environment, to integrate large numbers of very complex and interrelated projects in a fashion which produces the desired end products in any kind of reasonable time frame at the lowest possible costs.

The following sections describe the suggested accumulation of individual projects into a series of 12 Major Projects. While it is recognized that each Major Project impacts other Major Projects and is in turn impacted by them, the suggested grouping minimizes those impacts by "bundling" the most interrelated and/or interdependent projects into each Major Project - where the dependencies can be handled within the Major Project rather than in a global context which would be infinitely more complex.

The accompanying tables to each Major Project section also identify those projects and subprojects that currently reside in other organizational entities that should be transferred to the Major Project Office.

3.3.2 RECOMMENDED MAJOR PROJECTS

1. RADAR MODERNIZATION PROJECT (RAMP)
2. MICROWAVE LANDING SYSTEM (MLS)
3. FLIGHT DATA PROCESSING MODERNIZATION
4. FLIGHT SERVICE STATION MODERNIZATION
5. CONTROL, PERFORMANCE, AND MONITORING SYSTEMS
6. COMMUNICATIONS CONTROL SYSTEM
7. NAVIGATION SYSTEMS
8. COMMUNICATION SYSTEMS
9. RADAR AND AUTOMATION SYSTEMS
10. TELECOMMUNICATIONS NETWORK
11. MAINTENANCE
12. DEVELOPMENT

3.3.3 RADAR MODERNIZATION PROJECT (RAMP)

The need to provide a single special program office to contend with the intracacies of providing a well integrated and system -wide modernization of the Canadian Air Traffic Control radar surveillance system was recognized and subsequently developed by the Canadian Air Transportation Administration. This effot is aimed at the modernization of the civil radars across Canada through upgrading and new installations as well as upgrading and modernizing selected joint civil/military radars.

The Treasury Board has approved the Radar Modernization Project as a Major Crown Project and this special program office is now in operation.

Canada's Air Traffic Control System is functionally responsible for providing control and advisory services in the airspace overlying Canada and in international airspace for a major portion of the North Atlantic. Covering an area of approximately 5.8 million square miles, Canada's Air Traffic Control responsibilities are second only to those of the United States.

The Air Traffic Control System is a composite of interdependent subsystems used in conjunction with rules and procedures to control air traffic. Surveillance or radar data processing is one of the subsystems comprising the Air Traffic Control System. This system displays real-time air traffic situations using radar sensor derived information. Within high density traffic areas, reliance on radar data processing systems are an abosolute requirement for providing safe and efficient use of the airspace system.

The radar equipment and systems are being replaced because they do not meet the current operational performance requirements, they are of tube-type design, approximately twenty years old, and are very expensive and difficult to maintain. Some of the independent Secondary Surveillance Radar Systems will be used in lieu of Department of National Defense radars that also no longer meet the operational requirements of the Air Traffic Services.

The Radar Modernization Project proposes to procure and install new primary and secondary radar systems at twenty two (22) sites, a training system at Cornwall, and one non-operational system testbed at the Technical Systems Centre. Additionally, the project calls for Independent Secondary Surveillance Radar Systems at seventeen (17) sites as well as display and data processing systems at twenty nine (29) other sites across Canada, and a substantial modification package for the nine (9) Joint Enroute Terminal Systems.

The implementation of this project will take approximately twenty years. The first radar site installation is scheduled for 1987 and the last site for 1992.

The following table depicts: 1) The actual overall resources for this project; 2) The project elements assigned to this Major Project in the "bundling" process (accumulation of the most interrelated and interdependent projects); and 3) Projects and/or subprojects that currently reside in other organizational entities that should be transferred to this project.

RADAR MODERNIZATION PROJECT (RAMP)

OVERALL RESOURCES

The capital cost ceiling of the Radar Modernization Project is $810,504,000 and the capital person years required are 263.

PROJECT ELEMENTS

PROJECT ELEMENTS	CASP PAGE REFERENCE
RADAR DATA PROCESSING SYSTEM ENHANCEMENTS (JETS)	3-18
RADAR DATA PROCESSING SYSTEM FOR TCU'S AND TWR'S	3-24
RADAR MODERNIZATION PROJECT (RAMP)	6-68

PROJECTS AND/OR SUBPROJECTS TO BE TRANSFERRED TO THIS PROJECT

CURRENT PROJECT OR SUBPROJECT ELEMENTS	CURRENT APPROVED OR ESTIMATED FUNDS	PROJECT NUMBERS	PAD/CMR
JETS			
JETS Enhancements	45,000	S2-H124-2010	CMR
JETS	29,244,000	S2-H124-2040	CMR
JETS Minor Miscellaneous	45,000	S2-H124-7001	CMR
	29,334,000		

3.3.4 MICROWAVE LANDING SYSTEM (MLS)

As in the case of the Radar Modernization Project, recognition of the enormous task ahead in bringing the Microwave Landing System into the Canadian Airspace System, coupled with ICAO's decision as well as that body's requirement to operate and maintain the Instrument Landing System through 1995 necessitates the formation of a major project office capable of meeting these unique requirements. This Major Project will ensure that the new system is introduced in an evolutionary manner, while continuing operation and maintenance of the current system, and establish a schedule for the withdrawal of the the current system.

In 1978 the International Civil Aviation Organization (ICAO) accepted the Microwave Landing System (MLS) with the Time Reference Scanning Beam (TRSB) as the future precision approach and landing system for international application to replace the current standard, the Instrument Landing System (ILS). This system was selected after years of considering various alternatives to overcome the limitations of the current system which has significant deficiencies in its capabilities under difficult site conditions and extreme environmental conditions. The Microwave Landing System is seen as a more reliable system able to achieve the accuracies required to meet operational needs at a lower life cycle cost. The Microwave Landing System is also expected to achieve operational efficiencies as a result of its adaptability to various aircraft operational demands.

The Microwave Landing System comprises an azimuth installation, elevation installation, and a Precision Distance Measuring Equipment (DME-P) installation that together provide a three dimensional guidance system during approach and landing phases of aircraft operations. Complementary installations are also included which provide missed approach guidance. The system operates at microwave frequencies (at non-hazardous power levels) using time shared and computer techniques to achieve high accuracies and reliability. The system is adaptable to lower cost maintenance concepts and incorporates remote monitoring and maintenance capabilities.

It is intended that the Microwave Landing System be installed and operating at international airports to ensure that Canada meets the agreed Instrument Landing System protection date of 1995 established by the International Civil Aviation Organization. The withdrawal of Instrument Landing System service will begin soon after 1995 and be completed as soon as possible thereafter.

The project provides for the purchase and installation of 164 Microwave Landing Systems and associated equipment. These systems will replace 115 existing Instrument Landing Systems (98 precision, 11 non-precision, and 6 back courses), provide two systems for training, and 47 systems for expected growth to the year 2000. Note: The additional systems will be based on the current level of service as determined by present qualifying criteria for the establishment of precision approach guidance.

It is intended that the first operational installation will be commissioned by mid-1987 and installation at all existing precision Instrument Landing System locations by 1995. Between 1987 and for some time after 1995, it will be necessary to operate and maintain both the Instrument Landing System and the Microwave Landing System at most of the existing Instrument Landing System sites since the earliest permissible withdrawal of Instrument Landing Systems at international airports and alternates is 1995. The earliest possible withdrawal of the Instrument Landing Systems is therefore a highly desirable objective to minimize costs.

This project is currently being submitted for approval as a Major Crown Project.

The following table depicts: 1) The planned overall resources for this project; 2) The project elements assigned to this Major Project in the "bundling" process (accumulation of the most interrelated and interdependent projects); and 3) The projects and/or subprojects that currently reside in other organizational entities that should be transferred to this project.

MICROWAVE LANDING SYSTEM (MLS)

OVERALL RESOURCES

The capital cost estimate for this project is $454,711,000 and 352 person years. This estimate consists of: $302,460,000 for the purchase and installation of 164 Microwave Landing Systems; $152,251,000 for associated airport costs for the establishment of 47 growth systems. (S2-H127-0003 PAD)

PROJECT ELEMENTS

PROJECT ELEMENTS	CASP PAGE REFERENCE
MICROWAVE LANDING SYSTEM (MLS) AND PRECISION DISTANCE MEASURING EQUIPMENT (DME-P)	6-60
RVR SYSTEMS	6-62

PROJECTS AND SUBPROJECTS TO BE TRANSFERRED TO THIS PROJECT

CURRENT PROJECT OR SUBPROJECT ELEMENTS	CURRENT APPROVED OR ESTIMATED FUNDS	PROJECT NUMBER	PAD/CMR
MICROWAVE LANDING SYSTEM			
Advanced MLS Procurement	1,008,000	S2-H127-0002	CMR
MLS Research and Development	346,000	S2-H127-0004	CMR
MLS Studies	10,000	S2-H127-0005	CMR
Equip for STOL Facilities	3,927,000	S2-H127-0006	CMR
Test Equipment	249,000	S2-H127-0007	CMR
	5,540,000		
PRECISION DISTANCE MEASURING EQUIPMENT			
Precision DME Equipment	450,000	S2-H127-0001	CMR
RVR SYSTEMS			
RVR/DADS Investigation	45,000	S2-H126-2022	CMR
RVRS	2,716,000	S2-H126-2023	CMR
RVR	1,500,000	S2-H126-2029	PAD
	4,261,000		

3.3.5 FLIGHT DATA PROCESSING MODERNIZATION

A new Major Project is recommended to develop a new automated flight data processing system to automatically process and transfer flight data between all Air Traffic Control and user facilities to ensure that the flight data needs of all operators and users of the system are available and accessible and that such a system does not impose undue increases in resources to operate it.

The recommended project elements, in a singular and sometimes unrelated context, represent all current projects involved in providing this extremely important function.

To be able to provide any form of air traffic service information regarding the intended and actual movement of aircraft through the airspace in which services are to be provided is essential. The various elements of information used are known as flight plan data and control data. The activities that take place to acquire, process, distribute, and display this data are know collectively as flight data processing.

The present Canadian Flight Data Processing System is composed of various elements, each performing a particular function. The practices associated with operating these elements have evolved over a number of years and many of the methods used to perform the various tasks are labor-intensive, error prone, repetitive, and inefficient. The existing automated systems have limited growth potential in their flight data processing capabilities. These systems are not adaptable to meet the demands of increased traffic growth, improved flight management and area navigation systems, or to interface efficiently with the automated systems of the U.S. or other states with whom Canada has data exchange agreements.

The Flight Data Processing System will provide automatic and timely processing and transfer of flight data between all Air Traffic facilities and airlines. Accurate estimates of flight times, conflict probe and resolution, automatic generation of Air Traffic Control clearances, data for strategic flow management, and statistical data will also be provided. These capabilities will increase controller productivity and the system's capacity to cope with the air traffic growth. Benefits to users will be realized through reduced delays, reduced routing restrictions, and more fuel efficient operations.

The Flight Data Processing System located at each Area Control Center will evolve to support the flight data processing requirements for all Air Traffic Service facilities and users within the Flight Information Region. Initial upgrading of the Flight Data Processing System will improve flight data distribution, provide links with the Radar Data Processing System, provide local and remote controller work station printers, incorporate a weather model for the calculation of accurate flight time estimates, and provide automatic transfer of arrival and departure data. At selected Towers, Flight Service Station Hubs, and stand-alone Terminal Control Units, intelligent input and output devices will be provided and will be linked with the Flight Data Processing System. Airline flight planning systems will also be tied into the Flight Data Processing System.

Additional enhancements will include automatic updating of the Flight Data Processing System with aircraft real-time position data derived from the Radar Data Processing System or from surveillance systems. This function is a prerequisite to providing improved strategic flow management (direct and random routings), conflict prediction and resolution, optimum fuel efficient flight profiles, and implementation of the Advanced Integrated ATC System by the year 2000. The weather model will also be improved to include information on hazardous weather.

The following table depicts: 1) The planned overall resources for this project; 2) The project elements assigned to this Major Project in the "bundling" process (accumulation of the most interrelated and interdependent projects); and 3) The projects and/or subprojects that currently reside in other organizational entities that should be transferred to this project.

FLIGHT DATA PROCESSING MODERNIZATION

OVERALL RESOURCES

The total estimated capital cost for this project is $234,479,100 and 345 person years. The project will be funded in two phase: Project Initiation Phase, $5,236,200 and 68 person years; Project Implementation Phase, $229,242,900 and 277 person years. (S2-H119-1194 PAD)

PROJECT ELEMENTS

PROJECT ELEMENTS	CASP PAGE REFERENCE
GANDER AUTOMATED AIR TRAFFIC CONTROL SYSTEM ENHANCEMENTS (GAATS)	3-20
FLIGHT DATA PROCESSING SYSTEM	3-22
AERONAUTICAL INFORMATION PROCESSING SYSTEM	3-26

PROJECTS AND SUBPROJECTS TO BE TRANSFERRED TO THIS PROJECT

CURRENT PROJECT OR SUBPROJECT ELEMENTS	CURRENT APPROVED OR ESTIMATED FUNDS	PROJECT NUMBER	PAD/CMR
GAATS			
GAATS Refinements	476,000	S2-H124-2032	PAD CMR
System Enhancements	20,860,900	S2-H124-2035	APD
International Data Transfer	316,300	S2-H124-2038	PAD
Conflict Checking Capability	333,600	S2-H124-2039	PAD
	21,986,800		
NFDPS			
OIDS Enhancements	1,119,000	S2-H124-2027	PAD CMR
Flight Data Processing	7,724,000	S2-H124-2028	PAD CMR
	8,843,000		

3.3.6 FLIGHT SERVICE STATION MODERNIZATION

The Flight Service Station system encompasses all those services and facilities which provide information and advice to assist the pilot in the planning and conduct of his flight. The provision of such information is the primary responsibility of the Flight Service Station (FSS).

Aeronautical services and information are available to all sectors of the aviation community. However, while major airlines access certain flight information from other sources for internal distribution, the remainder of the aviation community depend almost solely on the Flight Service Station to provide all the required information and services directly to the pilot.

Canada has 116 Flight Service Stations offering a broad range of preflight and inflight services. These services include:

- Accepting and closing flight plans
- Briefing pilots
- Providing enroute communications with pilots
- Assisting pilots in distress
- Disseminating aviation weather information
- Status monitoring of air navigation radio aids
- Originating Notices to Airmen
- Working with Search And Rescue (SAR) units in locating missing aircraft

In addition, many Flight Service Stations also provide:

- Very High Frequency (VHF) direction finder service
- Observation and collection of weather data
- Dissemination of aviation weather reports
- Arrangements for Customs services for transborder flights
- Advisory information to arriving and departing aircraft
- Positive vehicle advisory at airports
- Relay of Air Traffic Control clearances and IFR position reports

The typical Flight Service Station is a one-position station located at an airport, operates 24 hours per day, and employs six Flight Service Specialists. Some Flight Service Stations will operate two or more positions due to workload or special requirements.

Interfacility data communications is provided by two national fixed telecommunications systems. One is used soley for the transmission and reception of weather data. The other is used for the relay of flight plan data, Notices to Airmen (NOTAM), and related flight plan information. Interphone links between Flight Service Stations and Air Traffic Control units enable the immediate exchange of flight data.

Aeronautical information is provided to pilots from Flight Service Stations by pre-recorded and live broadcasts, by telephone, or radio contact and person-to-person briefings. This information is used by the pilot to file a flight plan with the Flight Service Specialist.

Flight services will be improved through modernization and automation. Automated Weather Observing and Reporting Systems (AWORS), to be installed throughout Canada, will automatically collect and forward weather data through a communications system to the central weather computer. The processed aviation weather forecasts and reports will then be forwarded and stored in regional aviation weather processors. Pilots will be able to access this weather information through Direct User Access Terminals (DUAT) or by telephone. These terminals will also be linked to flight planning processors enabling "one stop" service for all flight planning requirements including the filing of the flight plan itself.

Automation of weather data collection is the key to Flight Service Station consolidation. By the year 2000 the 116 manned Flight Service Stations will be reduced to approximately 26 Flight Service Station Hubs, each managing several remote unmanned or part-time manned Satellite Flight Service Stations through the use of appropriate communications and automation.

Consolidation, along with automation, modernization, and innovative methods of disseminating aviation weather information will permit a substantial reduction in Flight Service Station personnel. At the same time, automation will ensure that the response and quality of the flight services provided are vastly improved.

Aviation weather service will be improved in quality and timeliness through automation. 300 observation sites will be fitted with Automated Weather Observing and Reporting Systems that will transmit pertinent aviation weather data to the central AES computer through Canadian Air Transportation Administration's aviation processors. Mass means of dissemination of aviation weather will be introduced. Dedicated video display terminals with keyboard access to aviation weather data banks will employ computer derived graphical displays to present weather in an easily interpretable format. Access to this real-time weather information will be streamlined. Flight Service Specialists will use automated display terminals to access aviation weather processors for pertinent information including the display of weather radar data.

Eventually, Direct User Access Terminals will be appropriately located to provide "one-stop" flight planning service. The pilot's action of entering his intended flight profile into a Direct Access User Terminal will trigger the display of pertinent weather and enroute flight information. When satisfied that all flight planning options are resolved, the pilot will action the terminal to transmit the flight plan to the Flight Data Processing System. Modern Transcribed Weather

Broadcasts (TWB) will have aviation weather data digitally stored. This information will be continuously transmitted over navigational aids or Very High Frequency Communication Outlets by an electronic speech generator, or on demand by telephone. The user may either dial specific aviation weather sequences pertaining to his planned flight or call up the full aviation weather briefing stored on a particular Transcribed Weather Broadcast.

Through automation a number of Flight Service Station Hubs will be established to operate in conjunction with Satellite Flight Service Stations. These Satellite Flight Service Stations will be operated with a minimum of on-site operations and maintenance personnel. By 1990 the number of manned Flight Service Stations will be reduced to approximately 70. Very High Frequency direction finder services provided at the Satellite Flight Service Stations will be remoted to Flight Service Station Hubs.

Initially, the Flight Service Specialist will have information display terminals in order to select (by location, area, and flight route) locally stored current aviation weather reports and forecasts to assist pilots with pre-flight planning. A subsequent phase will see Flight Service Station work stations and Direct User Access Terminals linked to regional aeronautical information and aviation weather data bases thereby providing all necessary preflight information. These Flight Service Station Hubs will provide comprehensive flight services over a wide geographic area. Unmanned and part-time manned Satellite Flight Service Stations located at airports will be operated through Flight Service Station Hubs. The Direct User Access Terminals at Satellite Flight Service Stations and other flight planning locations (flight dispatch offices, pilot lounges, etc.) will be able to provide all preflight information directly into the Flight Data Processing System through either the Flight Service Station work station or the Direct User Access Terminal. Further dissemination and presentation of the flight plan data will be accomplished automatically by the Flight Data Processing System.

Real-time weather data, including radar derived weather information will be graphically displayed at Flight Service Stations and on Direct User Access Terminals. This will improve preflight and enroute briefing services and assist the pilot in avoiding hazardous weather.

By the year 2000, the flight service system will consist of approximately 26 manned multi-position Flight Service Station Hubs with 126 Satellite Flight Service Stations.

The following table depicts: 1) the planned overall resources for this project; 2) The project elements assigned to this Major Project in the "bundling" process (accumulation of the most interrelated and interdependent projects) and 3) The projects and/or subprojects that currently reside in other organizational entities that should be transferred to this project.

FLIGHT SERVICE STATION MODERNIZATION

OVERALL RESOURCES

The total estimated capital cost for this project is $66,834,000 and 71 person years. (S2-H125-1023 (PAD)

PROJECT ELEMENTS

PROJECT ELEMENTS	CASP PAGE REFERENCE
FSS WORK STATIONS	4-12
GANDER AUTOMATED FSS (GAFSS)	4-18
CONSOLIDATION OF MANNED FSS	4-22
DIRECT USER ACCESS TERMINAL (DUAT)	4-14
AUTOMATED WEATHER OBSERVING AND REPORTING SYSTEM (AWORS)	4-16
TRANSCRIBED WEATHER BROADCAST (TWB)	4-20
CENTRAL AVIATION WEATHER PROCESSOR	5-08
REGIONAL AVIATION WEATHER PROCESSOR	5-10
VIDEO DISPLAY AVIATION WEATHER BROADCASTS	5-12

PROJECTS AND SUBPROJECTS TO BE TRANSFERRED TO THIS PROJECT

CURRENT PROJECT OR SUBPROJECT ELEMENTS	CURRENT APPROVED OR ESTIMATED FUNDS	PROJECT NUMBER	PAD/CMR
GANDER AUTOMATED FSS (GAFSS)			
Upgrade and Automate GAFSS	3,382,000	S2-H125-1039	PAD CMR
AWORS	63,462,000	S2-H125-1032	PAD
OTHERS			
Compressed Time Cassete Tape	102,000	S2-H125-1028	PAD CMR
Electronic Speech Generator Development	275,000	S2-H125-1027	PAD CMR
Meteorological Information Display System	200,000	S2-H125-1030	CMR

3.3.7 CONTROL AND PERFORMANCE MONITORING SYSTEM

This project is to develop and introduce remoted control, monitoring, and diagnostic appraisal of performance as a major factor in the maintenance of electronic systems and equipment serving the Canadian Airspace System. Because of the involvement with the maintenance activity generally and because of the computing power built into the control, monitoring, and diagnostic appraisal functions, the project will also gather operational data on all aspects of the maintenance activity and make use of the computing capability to provice maintenance information to management.

The system to perform the remote monitoring, control, and diagnostic appraisal is the Remote Maintenance Monitoring System (RMMS). This system and the Maintenance Management System (MMS) together form the Control and Performance Monitoring System.

The use of the Remote Maintenance Monitoring System will provide for the automatic monitoring and diagnosis of facilities and equipment from central locations. The need for travel by maintenance technicians will be reduced and the number of manned maintenance locations will be reduced from about 105 currently to 33 by the year 2000. The Remote Maintenance Monitoring System will permit staffing reductions and consolidation, improve the quality of worklife, improve workforce utilization, and increase workforce productivity.

The use of the Maintenance Management System will provide up-to-date and accurate information to be available to management to efficiently run the maintenance activity. Information will be readily entered and withdrawn directly from the system thus eliminating the current processing difficulties and provide information in a directly usable form.

The Maintenance Management System will improve equipment availability through trend analysis and support life-cycle responsibilities by providing accurate operating statistics such as actual mean times between failure and mean times to repair for the various systems and equipment. Records will be maintained providing information on areas such as inventory, parts usage, and personnel qualifications.

The Control and Performance Monitoring System is a very complex project both technically and organizationally. It must not only take into account equipment currently in the field but also take into account equipment to be procured in the future, when more sophisticated monitoring control and diagnostic features will be embedded in the equipment. Organizationally, the project cuts across all lines of responsibility as almost all the major projects are actively concerned with the system and its features. In addition, Headquarters and the Regions will be heavily involved as there will be large impacts on the organization of the workforce, with a need for flexibility in the method of implementation.

3.3.7.1 REMOTE MAINTENANCE MONITORING SYSTEM (RMMS)

The Remote Maintenance Monitoring System project element will be accomplished in three phases. To accomplish the project goal in a timely and cost effective manner, each phase will be a parallel effort under the direction of the Major Project Manager.

3.3.7.1.1 Phase I: REMOTE MAINTENANCE MONITORING SYSTEM (RMMS)

This phase of the project will establish a network of Maintenance Processor Subsystems at Maintenance Work Centers, provide standardized Remote Monitoring Subsystems, and incorporate these into existing solid-state systems, assure that newly acquired systems incorporate remote monitoring and control features, and interface with the Remote Maintenance Monitoring System network. Existing communication lines will be utilized initially for data transfer between subsystems. The Canadian Airspace System's Telecommunications Network will be used eventually for transmission and switching.

3.3.7.1.2 Phase II: MAINTENANCE CONTROL CENTER (MCC)

The Maintenance Program for the 1980's requires that facilities be remote maintenance monitored utilizing personnel located at central maintenance facilities. From these work centers, system monitoring and routine maintenance will be performed or personnel dispatched for corrective maintenance. The Maintenance Control Center will be the focal point for these activities. It will provide continuous monitoring for all remote facilities by using the Remote Maintenance Monitoring System network, act as the central communications point, and provide the capability to effectively dispatch, redirect, and manage the sector's workforce from these central maintenance facilities. The Maintenance Processor Subsystem will normally be placed at these locations.

3.3.7.1.3 Phase III: CENTRAL REPAIR FACILITY (CRF)

The Maintenance Program for the 1980's also requires on-site repair be limited to replacement of the Lowest Replaceable Units -- lamp and fuse replacement and repair of those units that cannot be reasonably be replaced and repaired at a central location. To satisfy that requirement, it is necessary to establish Central Repair Facilities.

In addition to the Lowest Replaceable Unit repair and adjustment, it is anticipated that test equipment repair and calibration will be accomplished at the Central Repair Facility. This facility may also become a part of depot storage for Lowest Replaceable Units as well as storage for repair piece parts.

Space, special tools, furniture, diagnostic software for existing automated test equipment, and a test equipment calibration laboratory will be provided at each location.

3.3.7.2 COMPUTER ASSISTED LEARNING

The use of Computer Assisted Learning (CAL) is one of the methods to be used to provide cost effective, high quality training for operational and technical personnel. It will be closely associated with specific equipment and simulation training at the Transport Canada Training Institute (TCTI). The results will:

- Significantly reduce travel costs associated with tradional training
- Provide flexibility for student self-pacing
- Provide nationwide standardization of training course material
- Provide rapid dissemination of development, refresher, and state-of-the-art training modules
- Provide improvements in employee productivity resulting from higher levels of skill and knowledge

Computer Assisted Learning terminals will be established at major facilities such as manned maintenance sites, Flight Service Station Hubs, Area Control Centers, and Terminal Control Units as well as at the Transport Canada Training Institute. The project will be conducted in two phases. In the first phase, research and development will be carried out to evaluate hardware and software to determine cost-effective methods of course production and delivery (on an on-going basis, also to minimize costs, Computer Assisted Learning packages will be specified and procured, when appropriate, as part of the contract in equipment procurements). In the second phase, training packages will be produced.

The following table depicts: 1) The current status for identifying project resources; 2) The project elements assigned to this Major Project in the "bundling" process (accumulation of the most interrelated and interdependent projects); and 3) The projects and/or subprojects that currently reside in other organizational entities that should be transferred to this project.

CONTROL AND PERFORMANCE MONITORING SYSTEM

OVERALL RESOURCES

Capital cost data including the number of capital person years are currently in the planning and formulation stage.

PROJECT ELEMENTS

PROJECT ELEMENTS	CASP PAGE REFERENCE
REMOTE MAINTENANCE MONITORING SYSTEM (RMMS)	8-18
COMPUTER ASSISTED LEARNING (CAL)	8-20

PROJECTS AND SUBPROJECTS TO BE TRANSFERRED TO THIS PROJECT

CURRENT PROJECT OR SUBPROJECT ELEMENTS	CURRENT APPROVED OR ESTIMATED FUNDS	PROJECT NUMBER	PAD/CMR
REMOTE MAINTENANCE MONITORING SYSTEM (RMMS)	997,000	S2-H125-2059	PAD
COMPUTER ASSISTED LEARNING (CAL)	225,000	S2-H122-5007	PAD

3.3.8 COMMUNICATIONS CONTROL SYSTEM

This major project will replace the current Communications Control Systems with new state-of-the-art equipment over a period of 15 years (The Communications Control Systems currently in use vary in age from 8 to 25 years. The older equipment is difficult to maintain and no longer meets current operational requirements). The equipment replacements will be phased in to minimize the operational and cost impacts that are normally experienced when whole systems are replaced.

The Communications Control System will permit one or more operators to access and control various communications circuits such as radios, hotlines, interphones, public telephone, and many other types of circuits. Every Air Traffic Control Facility has been equipped with one of the following systems:

- The Communications Control System (CCS) manufactured by Philips, Northern Radio, and Aquidata, between 1963 and 1968
- The Modular Communications Control System (MCCS) manufactured by Sperry from 1968 until 1983
- The Integrated Communications Control System (ICCS) manufactured by Rockwell International (Collins) between 1977 and 1979

The Integrated Communications Control System being the most recently installed system, will require replacement around 1992. The Modular Communications Control System, which will require some modifications to kept it in service, is a technologically updated version of the older Communications Control System and will require replacement beginning in 1990. The Communications Control System is the oldest of the three types, and its design is based on the technology of the late 1950's. It is now obsolete.

The present configuration of the Communications Control System equipment does not meet any current or projected operational and technical requirements. It does not provide a fully integrated communications capability where all voice communications are made available to the operator in one microphone and headset combination. Current operational requirements call for increased service availability to improve air navigation safety and efficiency. The system configuration required for this service availability cannot be accommodated by the existing Communications Control System.

A case in point is an operational requirement to upgrade 32 one-position Flight Service Stations to a two-position configuration in accordance with paragraph 5 of the Flight Service Station Standards Document (7-4ATNDS-3). These original systems lacked the flexibility in their design concept and cannot readily be adapted to meet changing requirements. The technology used in these systems, in other words, is obsolete; using wiring techniques common in the 1950's, expansion or modifications to this equipment is difficult and often introduces undersirable and unpredictable side effects, not to mention that wiring has deteriorated as well as the deterioration of the documentation, both physically and in accuracy. Additionally, costs of expansion or modification is higher than state-of-the-art technology because of the larger labor requirements involved in hand wiring.

The provision of spare assemblies and parts of the systems has also become a problem. Two of the equipment manufacturers are no longer in business and the third stopped supporting this equipment in 1970. All spare modules, assemblies, and a large proportion of the spare parts are now obtained by cannibalizing previously decommissioned Communications Control Systems.

The inherent design defects also reduce the quality of voice communications. These problems include hum and noise, interference from radio broadcast stations, interference between adjacent communications circuits and between operating positions, and various other deficiencies. All these contribute to operator fatigue and degradation of intelligibility of aeronautical communications which in turn could impact system safety and efficiency. (The old Communications Control System does not provide any protection to the operators against excessive exposure to noise and high sound levels. This potential health hazard is still under investigation following several grievances from operators.)

The new Communications Control Systems will upgrade overall system capability in that radios, hotlines, and landline communications will be integrated in such a manner that all voice communications will be made available to the controller in a single microphone/headset combination. The new off-the-shelf technology Modular Aeronautical Communications Switch will provide the following improvements:

- A systems approach design which integrates landlines and radio, integral remote control and monitoring of radio stations, landline signalling, recorder interfaces, and built-in test equipment.
- Performance capabilities to meet all specified operational and technical requirements
- Immunity to noise and interference
- Improved intelligibility
- Reduced operator fatigue and better hearing protection
- Central engineering support and configuration control in support of accountability
- Eliminate cost for leased common carrier equipment (a savings of approximately $1.1 million per year)
- Improved maintainability and higher operational availability
- Improved flexibility to meet changing requirements
- Improved life expectancy of up to 20 years
- Smaller physical dimensions
- Ease of installation and relocation

This project will be conducted in three phases:

Phase I will replace 105 systems installed in Air Traffic Control Towers, Terminal Control Units, and Flight Service Stations during the 1960's.

Phase II will replace 110 systems installed in Air Traffic Control Towers, Terminal Control Units, and Flight Service Stations during the 1970's. Procurement of systems for Flight Service Stations will be coordinated with the Flight Service Station Modernization and consolidation project.

Phase III will replace 9 integrated Communications Control Systems at Area Control Centers, Transport Canada Training Institute, Technical Systems Centre, and the Research and Engineering Centre.

The following table depicts: 1) The current status of identifying resources for this project; 2) The projects assigned to this Major Project in the "bundling" process (accumulation of the most interrelated and interdependent projects; and 3) The projects and/or subprojects that currently reside in other organizational entities that should be transferred to this project.

COMMUNICATIONS CONTROL SYSTEM

OVERALL RESOURCES

Capital cost data, including the number of capital person years, have not been developed for this major project.

PROJECT ELEMENTS

PROJECT ELEMENTS	CASP PAGE REFERENCE
COMMUNICATIONS CONTROL SYSTEM	3-28

PROJECTS AND SUBPROJECTS TO BE TRANSFERRED TO THIS PROJECT

CURRENT PROJECT OR SUBPROJECT ELEMENTS	CURRENT APPROVED OR ESTIMATED FUNDS	PROJECT NUMBER	PAD/CMR
Ancillary Communications Equipment	100,000	S2-H125-0006	PAD CMR
ICCS Field Support	71,000	S2-H125-0014	PAD CMR
Communications Control System Improvements	112,200	S2-H125-0019	PAD CMR
Modular Aeronautical Communications Switch	49,192,000	S2-H125-0022	PAD
ICCS Test and Maintenance Equipment	125,000	S2-H125-0023	PAD CMR

3.3.9 NAVIGATION SYSTEMS

This Major Project contains those project elements vital to the safety of air navigation in the Canadian Airspace System. Each project represents a navigational aid or system that are interrelated and/or interdependent, in one or more ways, to terminal and enroute flight operations.

The navigation systems, which provide guidance to aircraft, can be broadly divided between those which provide enroute guidance and those which provide approach and landing guidance although some are used for both purposes if they are suitably located.

The present route structure for the navigation of air traffic is based both on navigation and air traffic control requirements and is characterized by the strategic placement of Very High Frequency Omni=Ranges (VOR) and/or Non-Directional Beacons (NDB) for the delineation of airways (controlled airspace) and air routes (uncontrolled airspace). The VOR may be colocated with either Distance Measuring Equipment (DME) or military Tactical Air Navigation Systems (TACAN). Azimuth guidance is provided by the VOR whilst distance to the VOR is provided by either the Distance Measuring Equipment or the Tactical Air Navigation System. Non=Directional Beacons utilized in the enroute system are of high power (above 100 Watts).

The main disadvantage of the airway and air route method of navigation, at least for the longer range flights, is the lack of flexibility in routing. Some aircraft, equipped with area navigation systems, are capable of navigating on any desired track within the coverage of station-referenced navigation aids or within the limits of a self contained navigation system. This allows more direct and fuel-efficient routing through the system, which is limited at present by the requirements of the Air Traffic Control System.

Long range ground based navigational systems such as Omega and Loran C are not currently considered as an integral part of the present system. They are, however, becoming more widely used in areas where coverage is available and for special applications.

3.3.9.1 INSTRUMENT LANDING SYSTEM

This project element provides for the replacement and establishment of new Instrument Landing Systems as well as the incorporation of Remote Maintenance Monitoring in existing as well as the new equipment.

Contracts have been issued for the purchase of all current requirements and deliveries and installations begun.

3.3.9.2 VOR-DME-TACAN

This project element provides for new and replacement VOR, Distance Measuring Equipment, and Tactical Air Navigation Systems. VOR and Distance Measuring Equipment are used for enroute airway navigation, to provide navigation data to airborne area navigation systems and, in some cases, as approach aids. The Tactical Air Navigation System is a system used as a VOR-DME equivalent by the military and to provide Distance Measuring information for civil aircraft from colocated VOR/TACAN's.

Replacements. There are 51 VOR systems remaining to be replaced with solid state equipment during the period 1982-1988. A program will be established with the Department of National Defense to replace 32 colocated Tactical Air Navigation Systems between 1985 and 1990. No Distance Measuring Equipment will be replaced since all existing systems are currently solid state.

New requirements. Additional VOR-DME's will continue to be installed both for airway and area navigation in the high density traffic area and will eventually enable aircraft to operate on fuel efficient random routes. Expansion of the VOR-DME system will continue at a rate of 3 to 6 systems per year until 1995. Distance Measuring Equipment will be established at Non-Directional Beacons in the low density traffic area to provide for updating suitably equipped Inertial Navigation System aircraft.

Relocations. Due to performance decline, route structure changes, or real estate considerations it becomes necessary to convert standard VOR to Doppler VOR or to relocate facilities from time to time.

Upgrades. The new VOR, Distance Measuring Equipment, Tactical Air Navigation System equipment which will be procured after 1985 will incorporate full remote maintenance monitoring capability. Retrofit programs will be established to incorporate remote maintenance monitoring techniques into equipment procured prior to 1985. The incorporation of continuous weather broadcasts on VOR will be carried out in conjuntion with investigations of the desirability of utilizing voice identification.

3.3.9.3 NON-DIRECTIONAL BEACONS

This project element provides for the extension of the route structure to locations not presently served. To provide additional airports with non-precision approach guidance expansion of the Non-Directional Beacon system is required. The Non-Directional Beacon is a low to medium frequency facility that transmits onmidirectional signals whereby the aircraft pilot can determine his bearing and "home in" on the station. Non-Directional Beacons are used as navigation fixes defining air routes, as non-precision approach systems and as compass locators for precision landing systems. About half of the existing Non-Directional Beacons installations require replacement with solid state equipment. The addition of remote maintenance monitoring and continuous weather broadcasts will be required at both existing and new Non-Directional Beacon sites.

3.3.9.4 VHF-DF

This project element will expand the VHF-DF coverage in order to provide assistance to pilots experiencing navigational difficulty and for aircraft identification and control purposes. It will incorporate Direction Finding bearing and/or fix information with the Radar Data Processing Systems and Flight Service Station workstations. The application of remote maintenance monitoring will also be incorporated. Some relocations will be carried out to consolidate VHF-DF sites with other facilities.

The existing coverage provided by terminal VHF-DF's will be expanded by additional systems and by suitably located enroute systems. Output bearing data from Direction Finders will be correlated in order to establish aircraft fixes where overlapping coverage by two or more Direction Finders are available. Remote maintenance monitoring will be retrofitted into all existing and future installations.

3.3.9.5 FLIGHT INSPECTION SYSTEMS

This project element will implement an automated all-weather flight inspection system in order to increase the efficiency of flight inspections and improve the quality of the measurements.

The project will be carried out in two complementary subprojects. The first will be the development of a Digital Flight Inspection System having an on-board capability to digitize and record measurement data, automatically calculate the navigation aids parameters, and provide an evaluation of the facility being measured. The system can operate both with theodolite measurements from the ground and with the highly accurate positioning system being developed in the second effort.

The second subproject will be the development of a Self-Contained Aircraft Positioning Equipment (SCAPE) with a highly accurate positioning capability for the flight inspection aircraft. This equipment will eliminate the need for theodolite tracking and associated personnel. The combination of the Digital Flight Inspection System and the Self-Contained Aircraft Positioning Equipment will provide a weather independent flight inspection capability. The capability of these systems to record and rapidly assess results will be implemented in the new flight inspection fleet in the 1985 to 1986 time frame.

A preproduction Digital Flight Inspection System is presently undergoing test in an Ottawa based aircraft. The feasibility of the Self-Contained Aircraft Positioning Equipment has already been demonstrated.

The following table depicts: 1) The current status of identifying resources for this project; 2) The project elements assigned to this Major Project in the "bundling" process (accumulation of the the most interrelated and interdependent projects); and 3) The projects and/or subprojects will be retained within the project.

NAVIGATION SYSTEMS

OVERALL RESOURCES

Capital cost data including the number of capital person years are currently in the planning and formulation stage

PROJECT ELEMENTS

PROJECT ELEMENTS	CASP PAGE REFERENCE
INSTRUMENT LANDING SYSTEM	6-58
VOR-DME-TACAN	6-48
NON-DIRECTIONAL BEACONS	6-50
VHF-DF	6-52
FLIGHT INSPECTION SYSTEMS	8-12
FLIGHT INSPECTION FLEET PLAN	8-14
ONGOING MAINTENANCE	

CURRENT PROJECTS TO BE RETAINED IN THIS PROJECT

CURRENT PROJECT OR SUBPROJECT ELEMENTS	CURRENT APPROVED OR ESTIMATED FUNDS	PROJECT NUMBER	PAD/CMR
INSTRUMENT LANDING SYSTEM			
ILS Equipment Procurement	3,778,000	S2-H126-2002	PAD CMR
ILS Ground Check System	30,000	S2-H126-2005	CMR
	25,000	N2-H126-2005	CMR
Tube Type ILS Replacement	5,200,000	S2-H126-2017	PAD CMR
	1,011,000	N2-H126-2017	CMR
Engineering Studies	82,000	S2-H126-2025	CMR
Field Support	68,000	S2-H126-2026	PAD CMR
	10,194,000		

VOR-DME-TACAN

VOR/DME Prefab Structures	249,000	S2-H126-0044		CMR
Bulk VOR/DME Procurement	9,669,000	S2-H126-0047	PAD	CMR
Raytheon SS VOR Modification	249,000	S2-H126-0053		CMR
Procure VOR/DME Remote Control Systems	480,000	S2-H126-0056	PAD	CMR
	121,000	N2-H126-0056		CMR
Bulk Procure VOT Equipment	895,000	S2-H126-0061	PAD	CMR
Bulk Procurement-Four DME	256,000	S2-H126-0063		CMR
Bulk VOR/DME Procurement	33,859,000	S2-H126-0065	PAD	
Transport Canada Costs For TACAN Replacement	4,131,600	S2-H126-0066	PAD	CMR
	49,829,600			

NON-DIRECTIONAL BEACONS

Beacon Monitor Receivers	45,000	N2-H126-0027		CMR
Low Power Radio Beacon	795,000	S2-H126-0057	PAD	CMR
	263,000	N2-H126-0057		CMR
High Power Radio Beasons	1,691,000	S2-H126-0058	PAD	CMR
	564,000	N2-H126-0058		CMR
Beacon Monitor Receivers	95,000	S2-H126-0059	PAD	CMR
	32,000	S2-H126-0059		CMR
High Power NDB For ONT NWT QUE	654,000	S2-H126-0064	PAD	CMR
	64,000	N2-H126-0064		CMR
	4,203,000			

VHF-DF

Procure VHF-DF Navaids	2,819,000	S2-H126-0046		CMR
	274,000	N2-H126-0046		CMR
	3,093,000			

FLIGHT INSPECTION SYSTEMS

Develop New F/I Systems Retrofit SKA-100 Aircraft	3,230,000	S2-H126-1002	PAD	CMR
Calibrate Standard Laboratory Equipment	500,000	S2-H126-1006		CMR
Improve Flight Check Equipment	68,000	S2-H126-1008	PAD	CMR
Experimental Projects And Improvements In Support of Flight Inspection	74,000	S2-H126-1009	PAD	CMR

Contingency Replacement of Flight Inspection Equipment	34,000	S2-H126-1020	PAD	CMR
Self Contained Aircraft Position-Fixing Equipment (SCAPE)	6,080,000	S2-H126-1025	PAD	CMR
Inertial Navigation System Repair	22,000	S2-H126-1026	PAD	CMR
	10,008,000			

OTHER

Enroute Aids Electrical Generation Plants	109,000	S2-H126-0029		CMR
	10,000	N2-H126-0029		CMR
Enroute Aids Engineering Study	35,000	S2-H126-0030		CMR
Enroute Aids Miscellaneous Items	42,000	S2-H126-0031		CMR
Transmissometer Retrofit	1,236,000	S2-H126-2021		CMR
Navaids Engineering Studies	153,000	S2-H126-4014		CMR
	1,585,000			

3.3.10 COMMUNICATION SYSTEMS

Ground-to-air communications facilities provide voice radio communications between controllers and pilots in both enroute and terminal airspace. Other ground-to-air facilities provide communications between pilots and Flight Service Specialists.

The elements recommended in this Major Project provides for all communications requirements in the Air Traffic Control system to ensure flight following.

Ground-air Very High Frequency and Ultra High Frequency communications stations, both local and remote, are located to give coverage for each air traffic control sector, as well as for Flight Service Station communications. About 50% of the existing communications transmitters and receivers use solid state technology and the remainder are due for replacement. Ultra High Frequency equipment is currently fully solid state. Very High Frequency equipment has been converted to 25 KHz spacing for use in the airspace above 18,000 feet. Conversion to 25 KHz channel spacing for low level airways and terminal areas will be implemented where frequency congestion occurs.

Long-range High Frequency facilities are used to communicate with international flights over oceanic areas and in Northern Canada where it has not yet been economical or possible to provide complete Very High Frequency coverage. Generally, all the High Frequency transmitters associated with international operations are modern but the receivers are old and will be replaced. The High Frequency transmitters and receivers associated with domestic operations are also due for replacement.

Present communications facilities do not include remote maintenance monitoring.

3.3.10.1 AIR GROUND VHF COMMUNICATIONS

This project element is aimed at replacing obsolete Very High Frequency communications equipment with highly reliable state-of-the-art models capable of operating in a 25 KHz environment. Antennas will be replaced with designs that will provide better coverage patterns and higher isolation. Also, transmitters, receivers, multicouplers, and antennas will be provided to meet the expansion of Air Traffic services and for the extension of communications services into remote areas.

Increases in the demand for communications services in Air Traffic services have generated a requirement for additional channels. This can only be accomplished in the frequency spectrum by decreasing the channel spacing to 25 KHz. This channel spacing cannot be done economically with the older equipment.

The higher reliability associated with modern equipment makes it possible to reduce the requirement for periodic maintenance resulting in a savings of 40 hours per year for each transmitter and receiver pair.

A reduction in power consumption will also result by the conversion to more efficient equipment. It is estimated that 2.0 megawatt-hours per year will be saved by each transmitter and receiver pair.

3.3.10.2 AIR GROUND HF COMMUNICATIONS

This project element is designed to replace obsolete tube-type transmitters and receivers with more reliable, efficient solid-state equipment. This equipment is used principally on the 5680 KHz service available at northern Flight Service Staions to provide communications with aircraft operating beyond Very High Frequency range in the low density traffic area. Some equipment is also required to provide Internationa Civil Aviation Organization service for international air-ground communications and to provide for ground-ground links.

Existing equipment exhibits poor availability, high energy utilization, and high maintenance costs. It also fails to meet international frequency stability requirements. The new units will decrease maintenance and energy costs by at least 50%.

3.3.10.3 CONSOLIDATION OF COMMUNICATION, NAVIGATION AND SURVEILLANCE FACILITIES

This project element is aimed at physically consolidating and collocating, where feasible, communication, navigation, and surveillance facilities.

There are at present approximately 350 facility sites which can be considered for consolidation. This will result in cost savings through land use reductions, reduced maintenance travel, reduced site maintenance (heating, air conditioning, road maintenance), and reduction in interfacility communications.

Consolidation will be initiated at sites where multiple communications facilities exist and when solid-state equipment and remote maintenance monitoring is installed. Remote communications facilities not already associated with Non-Directional Beacons and/or VOR's will be consolidated. Where possible consolidation of VOR and Very High Frequency Direction Finding will be considered. New and stand-alone peripheral communication facilities will be consolidated with their associated surveillance site.

The following table depicts: 1) The current status of identifying resources for this project; 2) The project elements assigned to this Major Project in the "bundling" process (accumulation of the most interrelated and interdependent projects); and 3) The projects and/or subprojects to be retained within the project.

COMMUNICATION SYSTEMS

OVERALL RESOURCES

Capital cost data including the number of capital person years are currently in the planning and formulation stage.

PROJECT ELEMENTS

PROJECT ELEMENTS	CASP PAGE REFERENCE
AIR GROUND VHF COMMUNICATIONS	6-42
AIR GROUND HF COMMUNICATIONS	6-44
CONSOLIDATION OF COMMUNICATIONS, NAVIGATION, AND SURVEILLANCE FACILITIES	6-74
ONGOING MAINTENANCE	

CURRENT PROCUREMENTS

CURRENT PROJECT OR SUBPROJECT ELEMENTS	CURRENT APPROVED OR ESTIMATED FUNDS	PROJECT NUMBER	PAD/CMR
AIR GROUND VHF COMMUNICATIONS			
VHF Fixed Tuned Receiver	63,000	N2-H125-2006	CMR
VHF Transceiver Procurement	993,000	S2-H125-2044	CMR
	151,000	N2-H125-2044	CMR
Audio Processing-Limiter	136,000	S2-H125-2053	CMR
VHF Transmitter/Receiver and Monitor/Control Coupler	10,305,000	S2-H125-2055	CMR
	1,321,000	N2-H125-2055	CMR
	12,969,000		
AIR GROUND HF COMMUNICATIONS			
HF Communications Equipment	6,783,700	S2-H125-2048	PAD

OTHER

Engineering Studies	32,000	S2-H125-0012		CMR
Aircraft Noise Monitor System	925,000	S2-H125-1011		CMR
Multi-Channel Magnetic Recorder	912,000	S2-H125-1015	PAD	CMR
Recording Facility For Emergency Transceivers	32,000	S2-H125-1018	PAD	CMR
Equipment Modifications And Evaluation	45,000	S2-H125-1025		CMR
Multi-Channel Magnetic Recorder	664,900	S2-H125-1033	PAD	
Communications Receiving Equipment	114,000	S2-H125-2005		CMR
	32,000	N2-H125-2005		CMR
Radio System Engineering Studies	48,000	S2-H125-2046		CMR
SELCAL ground Station Equipment	169,000	S2-H125-2054		CMR
Modify Radio Systems	20,000	S2-H125-2056		CMR
Engineering Studies	15,000	S2-H125-2057		CMR
Control Surveillance System For Air Ground	3,054,000	S2-H125-2058	PAD	CMR
Solid State Transmitters And Receivers For Air Ground Communications	11,285,800	S2-H125-2060	PAD	
Remote Control And Monitoring Equipment	478,000	S2-H125-2062	PAD	CMR
Electronic Security Engineering Study	40,000	S2-H125-3005		CMR
Man-Machine Study Phase I	45,000	S2-H125-5005		CMR
Man-Machine Study Phase II	31,000	S2-H125-5009		CMR
Engineering Development Studies	63,000	S2-H125-5013		CMR
Optical Communication Study	89,000	S2-H125-5014		CMR
Aviation-Communication Propagation Study	477,000	S2-H125-5021		CMR
Network And Terminal Development Phase II	46,000	S2-H125-5022		CMR
	18,617,700			

3.3.11 RADAR AND AUTOMATION SYSTEMS

The elements recommended in this Major Project provide for all radar surveillance and detection requirements in the Air Traffic Control system including surface and enroute surveillance and weather detection.

3.3.11.1 RESEARCH AND EXPERIMENTATION SYSTEM ENHANCEMENTS

As Air Traffic Service automation systems evolve, considerable use will be made of the Research and Experimentation Centre to simulate and evaluate the introduction of new Air Traffic Control functions and to study their impact on the operation. Studies, such as the introduction of conflict resolution, air-ground data transfer, automatic issuance of clearances, which will progressively alter the role of the air traffic controller, will have to be thoroughly proven before they are operationally used.

A continuing schedule of enhancement and expansion is planned beginning with replacement of existing hardware (computer systems and pilot position terminals) capable of operating with existing software. Software conversion to the new mainframe hardware will be effected through a host and rehost process. Early implemenation of fast-time simulation and additional mathematical modelling capabilities will be introduced. Along with the replacement of hardware, the system will be enhanced to undertake comprehensive human engineering studies that will be required to pace the development of the highly automated Air Traffic Control systems of the 1990's. Appropriate hardware and software modules will be included to permit the study of wider applications such as Flight Service Station operations, user friendly weather information access systems, and air-ground data link operations (including dependen surveillance and automatic clearances to aircraft). To enable the investigation of problems in the total integration of Air Navigation Systems, a flight simulator will be added to the Research and Experimentation Centre.

Software packages developed for the Research and Experimentation Centre will be adapted for use in Controller Training and Proficiency Evaluation Simulation Systems.

As indicated in the Technical Systems Centre narrative, the two facilities should be consolidated.

3.3.11.2 CONTROLLER TRAINING AND PROFICIENCY EVALUATION SIMULATION SYSTEM

This effort provides the necessary training facilities and environments (sterile or non-sterile) for controller training and proficiency evaluation of new systems and procedures. They are mainly located at the Transport Canada Training Institute, Regions, and Air Traffic Control Facilities.

The main focus of this project is the replacement of certain hardware and the upgrading of mirrored systems at the Transport Canada Training Institute. These involve research into the areas of Air Traffic Control simulators that emulate the "real world" controller environment.

3.3.11.3 WEATHER RADAR

This project is designed to provide an aviation weather radar network that will disseminate timely and accurate aviation weather data to Air Traffic Facilities and aviation users.

The identification and presentation of real time hazardous weather information from a system of weather radars will have a net benefit to the users in reducing or eliminating unexpected or uncoordinated traffic diversions, provide more fuel efficient routings, and improve flight safety.

3.3.11.4 AIRPORT SURFACE DETECTION EQUIPMENT

This project element provides selected towers with surveillance data of the position of aircraft and vehicles on the manuevering area of the airport. The system is enhanced by providing alphanumeric aircraft identification tags for Airport Surface Detection Equipment displays.

At busy airports, the monitoring of aircraft and vehicle positions, particularly in reduced visibility conditions, is required to ensure safe and efficient operations.

A contract will be issued to provide for equipment and installation of Airport Surface Detection Equipment systems at seven major airports. Deliveries of systems will began in 1984 with the last of these being installed by 1988. The three systems presently installed will be replaced under this program. Additional systems may be required in the future as traffic demands warrant.

The following table depicts: 1) The current status of identifying resources for this project; 2) The project elements assigned to this Major Project in the "bundling" process (accumulation of the most interrelated and interdependent projects); and 3) The projects and/or subprojects to be retained within this project.

RADAR AND AUTOMATION SYSTEMS

OVERALL RESOURCES

Capital cost data including the number of capital person years are currently in the planning and formulation stage.

PROJECT ELEMENTS

PROJECT ELEMENTS	CASP PAGE REFERENCE
RESEARCH AND EXPERIMENTATION SYSTEM ENHANCEMENTS	3-42
CONTROLLER TRAINING AND PROFICIENCY EVALUATION SIMULATION SYSTEM	3-44
WEATHER RADAR	6-66
AIRPORT SURFACE DETECTION EQUIPMENT	6-70
ONGOING MAINTENANCE	

CURRENT PROJECT OR SUBPROJECT ELEMENTS	CURRENT APPROVED OR ESTIMATED FUNDS	PROJECT NUMBER	PAD/CMR
AIRPORT SURFACE DETECTION EQUIPMENT			
ASDE Phase II	13,530,000	S2-H124-0002	PAD CMR
ASDE Evaluation Support	99,000	S2-H124-0019	PAD CMR
	13,629,000		
OTHER			
ATC Radar Support	483,000	S2-H124-0022	PAD CMR
Replace VMK Mappers	662,000	S2-H124-0023	PAD CMR
SSR Open Array Antennas	468,000	S2-H124-0025	PAD CMR
Video Map Generators	211,000	S2-H124-0027	PAD CMR
SSR Interogator	350,000	S2-H124-0029	PAD CMR
WPG Open Array Antennas	300,000	S2-H124-0030	PAD CMR
ATS Flight Data Study	121,000	S2-H124-2014	PAD CMR
Flight Data Display Evaluation	445,000	S2-H124-2021	PAD CMR
Auto Systems Support	70,000	S2-H124-2030	PAD CMR
OIDS Station Spares	92,000	S2-H124-2031	CMR
Computer Interface Hardware	44,000	S2-H124-2034	PAD CMR
TDM Workstation Enhancement	857,000	S2-H124-2036	PAD CMR

OIDS Floppy Disk Purchase	145,000	S2-H124-2037	PAD	CMR
Digitizer Improvements	8,000	S2-H124-4016	PAD	CMR
Airborne SSR Test Facility	45,000	S2-H124-4017		CMR
Parrot-SSR Ground Test	235,000	S2-H124-4028	PAD	CMR
Radar Improvements	15,000	S2-H124-4037	PAD	CMR
Engineering Investigations	25,000	S2-H124-5001	PAD	CMR
Radar And Automation Equipment	75,000	S2-H124-5002	PAD	CMR
Software Investigations	15,000	S2-H124-6026	PAD	CMR
Radar Processing	45,000	S2-H124-6027	PAD	CMR
Radar Data Multi-Processor	45,000	S2-H124-6030	PAD	CMR
Radar Sensor And Siting	75,000	S2-H124-6031	PAD	CMR
Radar And Automation Invest.	75,000	S2-H124-6032	PAD	CMR
Radar Updating Study	49,000	S2-H124-6033	PAD	CMR
Raster Display Technology	98,000	S2-H124-6038	PAD	CMR
Radar Site Data Development	50,000	S2-H124-6039	PAD	CMR
	5,103,000			

3.3.12 TELECOMMUNICATIONS NETWORK

Interfacility systems provide voice and data communications between major facilities such as Air Traffic Area Control Centers (ACC), Terminal Control Units (TCU), Flight Service Stations (FSS), and Towers; smaller remote facilities such as navigation aid, communication, and surveillance sites; and internationally with the United States, Europe, Iceland, and Greenland. In general, dedicated circuits used exclusively by Transport Canada carry voice and/or data between facilities. Point-to-point voice grade circuits provide links between Air Traffic Service facilities and provide links for the monitoring and control of navigation, communication, and surveillance sites. The circuits provide links to over 18,000 systems installed at more than 2,000 sites as a leased cost of over $19,000,000 annually.

Although most interfacility systems are leased, some are owned by the Canadian Air Transportation Administration. These owned systems are either radio links (microwave for radar data or UHF/VHF for remote monitoring, control, and operation) or cable distribution systems on airports (e.g. for Instrument Landing System remote monitoring, control, and operation). Within each operational unit there are several intrafacility systems consisting of voice or data local area networks for each sub-system. These local area networks (as used by systems such as the Integrated Communications Control System, Joint Enroute Terminal System, Operational Information Display System, etc.) are not interlinked at the present time.

The leased services are provided by the major Common Carriers for national and international systems and the local Common Carriers for local regional circuits. Canada fulfills its commitment to the world-wide Aeronautical Fixed Telecommunication Network (AFTN) with a low speed teletype domestic network called the Automated Data Interchange System (ADIS). This system interfaces internationally with a circuit to the United States and several circuits to Europe, Iceland, and Greenland. The Automated Data Interchange System is also interconnected to the centralized automated NOTAM system. The AES Meteorological teletype network, for the most part, parallels the Automated Data Interchange System network but is not interconnectable to that system. Present day voice and data communication networks have been implemented for specific service functions and are not interconnectable. Short distance, point-to-point circuits (such as the cross-border circuits to the United States) have proliferated over the years in an attempt to solve local operational problems.

In order to establish a foundation for network evolution to the Canadian Aeronautical Digital Network, activities are underway to upgrade system performance with emphasis on constraining costs.

In the long term, as more facilities are consolidated, as Secondary Surveillance Radar Mode S and datalinked dependent surveillance are introduced and as more automated stations are installed, increasing interfacility requirements must be accommodated. Digitized voice and data will be integrated into a distributed Canadian Aeronautical Digital Network. The redundancy built into the network will ensure high reliability and availability.

In addition to the data carried by the Automated Data Interchange System, the increased requirements stipulated in the Canadian Airspace Systems Plan, the International Civil Aviation Organization planning for the Common Data Interchange Network (the future evolution of the Aeronautical Fixed Telecommunication Network), the digitization of the voice networks, and future unforeseen requirements necessitate a complete updgrade of the interfacility system to the Canadian Aeronautical Digital Network.

As the Canadian Aeronautical Digital Network evolves into an all encompassing digital communications network, it will provide the required flexibility and interoperability demanded by the Canadian Airspace System. The alternative of dedicated independent lines will not provide the above capability and would be cost prohibitive.

A highly connected, code and byte independent, switched network with virtual circuit and alternate routing capability will be implemented to initially accommodate the data communications needs. As work progresses on the digitization of voice systems they will be integrated into the Canadian Aeronautical Digital Network. A centralized network control and monitoring facility will be established. Standardization of access interface and an appropriate protocol will be maintained to ensure future flexibility and evolution of the system. Message switching will continue to be provided for quick response, interactive data transfer, and efficient file (data base) transfer capability. Nodes and concentrators will be added as required.

The following table depicts: 1) The current status of identifying resources for this project; 2) The project elements assigned to this Major Project in the "bundling" process (accumulation of the most interrelated and interdependent projects); and 3) The projects and/or subprojects that are to be retained in the project.

TELECOMMUNICATIONS NETWORK

OVERALL RESOURCES

Capital cost data including the number of capital person years are currently in the planning and formulation stage.

PROJECT ELEMENTS

PROJECT ELEMENTS REFERENCE	CASP PAGE
ADIS SWITCHING CENTRE	7-14
NOTAM SYSTEM AUTOMATION	7-16
NETWORK RECONFIGURATION AND INTEGRATION	7-18
CANADIAN AERONAUTICAL DIGITAL NETWORK	7-20

CURRENT PROCUREMENTS

CURRENT PROJECT OR SUBPROJECT ELEMENTS	CURRENT APPROVED OR ESTIMATED FUNDS	PROJECT NUMBER	PAD/CMR
Network System Investigation	198,400	S2-H133-1001	PAD CMR

3.3.13 MAINTENANCE

3.3.13.1 ELECTRICAL POWER SYSTEMS (PRIMARY AND SECONDARY)

There is a need to improve the reliability and availability of electrical power systems. In view of the high reliability of the other equipment, electrical power is now a weak link in the performance of many systems. The reliability and availability of electrical power must be improved and the need for maintenance of the electrical power systems reduced, prior to consolidation of the maintenance workforce. An availability study has shown that loss of power to equipment contributes to 90% of the system outages.

Large back-up power requirements, such as in Aera Control Centres, are currently backed up by complex emergency power units, which are maintainance intensive and prone to failure. An investigation of such power systems will be undertaken to reduce complexity and improve reliability and availability. Small back-up power requirements can be readily made more reliable by the installation of Static Uninterruptible Power Units (SUPU) which provide a battery based Direct Current (DC) power supply in the event of power failure.

The provision of primary power, other than that provided by public utilities, is an area of great importance. The use of air cooled rather than liquid cooled diesels, for example, has been shown to significantly reduce diesel generator maintenance requirements and the use of distributed Direct Current power, on site, can greatly simplify back-up power arrangements. The reduction of power requirements in many areas, due to the use of solid state equipment, has opened the door to other highly reliable sources of prime power. Such sources, for example, include solar arrays used in conjunction with rechargeable batteries, as well as water-activated disposable batteries cocooned in insulation with built-in heating capability, which can provide reliable power for a year or more at remote sites.

Development of a national plan to improve power and environmental systems for all facilities is required. The responsibility for power systems should be clearly documented including life-cycle maintenance and logistics support.

The following table depicts: 1) The current status of identifying resources for this project; 2) The project elements assigned to this Major Project in the "bundling" process (accumulation of the most interrelated and interdependent projects); and 3) The projects and/or subprojects that will be retained by the project.

MAINTENANCE

OVERALL RESOURCES

Capital cost data including the number of capital person years are currently in the planning and formulation stage.

PROJECT ELEMENTS	CASP PAGE REFERENCE
PROJECT ELEMENTS	
ELECTRICAL POWER SYSTEMS (PRIMARY AND SECONDARY)	8-16

CURRENT PROCUREMENTS

CURRENT PROJECT OR SUBPROJECT ELEMENTS	CURRENT APPROVED OR ESTIMATED FUNDS	PROJECT NUMBER	PAD/CMR
Radar Uninterruptible	918,000	S2-H124-0028	PAD CMR
Radar No Break Power RUPU	1,130,000	S2-H124-3018	CMR
IPU For Sault Ste. Marie	50,000	S2-H124-4038	PAD CMR
	2,098,000		

3.3.14 DEVELOPMENT

The project elements recommended under this Major Project are those requirements that are just starting or are in the process of being developed into research and development projects. These projects are normally in the system engineering design phase and will be directed through one of the Major Project organizational units (i.e. Navigation Systems, Communication Systems, Radar and Automation Systems, and Telecommunications Network). When these projects are matured and ready for system integration, the project(s) will be handed off to another Major Project for final project execution.

This initiation and flow relationship is shown in Figure 3-4 which maps all Canadian Airspace Systems Plan projects into a recommended Major Project structure which in turn includes the current approved Facility Engineering and Systems Development organizational structure.

3.3.14.1 CONFLICT PREDICTION AND MINIMUM SAFE ALTITUDE WARNING

This project element is designed to provide air traffic controllers with computer generated conflict prediction alerts and minimum safe altitude warnings.

These functions will assist air traffic controllers by identifying potential conflict situations between Mode C transponder equipped aircraft, as well as alerting them to aircraft ground proximity situations. These enhancements are prerequisites to computer generated conflict resolution advisory. The inclusion of these conflict prediction functions will provide added system safety during the period of increasing growth in air traffic.

Software to perform these functions will be developed and implemented in the central processing complex of the Radar Data Processing System at Area Control Centres. At stand-alone Terminal Control Units hardware will be added to incorporate common software for providing conflict prediction and minimum safe altitude warning functions which will be distributed to the air traffic controller work stations via the local area network.

3.3.14.2 CONFLICT RESOLUTION ADVISORY

This project element provides for computer generated aircraft conflict resolution advisories (alternatives) when violation of separation minima is about to occur. The objective of this function is to reduce the number of system errors (losses of separation).

With the forecasted growth in air traffic and the complexity of operations associated with providing aircraft fuel efficient direct routes, this function will be an essential aid to the air traffic controller. The inclusion of conflict resolution advisory will need to be studied in the context of the changing role of the air traffic controller and the highy automated Air Trafffic Control environment. Based on functional specifications, engineering development of a prototype will be evaluated at the Research and Experimentation Centre before the acquisition of software packages for implementation in operational systems. The operational implementation of this function is a prerequisite for the Advanced Integrated ATC System.

3.3.14.3 METERING AND SEQUENCING

This project element provides for computer generated assistance to the air traffic controller's responsibility in managing air traffic and optimizing traffic flows during the arrival and departure phases of flight.

In the complex air traffic environment of terminal area operations (involving climbing, turning, accelerating, decelerating, and descending traffic) the efficient and expeditious management of traffic flow is necessary to avoid undue delay while maintaining safety. Metering and sequencing software will continuously model and predict the traffic sequencing to the air traffic controller and will be sensitive to parameters such as runway capacity, weather conditions, and wake turbulence. The software will provide an automated interface with enroute air traffic (Flow Management System).

Developmental activity at the Technical Systems Centre will lead to the design and specification of software and its extensive testing before it is adapted for operational use in all Terminal Control Units. Since the software (algorithms), in its final form, is likely to be complex, it is proposed to develop the capability for metering and sequencing in phases.

Phase I - Development of the metering and sequencing system and operational concept for a stand alone runway capacity traffic management system.

Phase II - Expansion of the initial capability through development of a Terminal Control Area planning aid which will include runway capacity traffic management, airspace configuration management, arrival flow planning (sequencing), and departure flow planning (metering).

Phase III - Development of a Terminal Control Area Tactical Executor which will automatically generate clearances and directives (data linked to aircraft).

3.3.14.4 MODE S DATA LINK UPGRADE

This project element provides a data link capability, using Mode S Secondary Surveillance Radar, to permit automatic exchange of Air Traffic Service messages, weather, and automated traffic advisory information. This capability will be provided in the high density traffic area consistent with the coverage of Secondary Surveillance Radar.

The monopulse Secondary Surveillance Radar equipment will be modified to incorporate Mode S capability and thus provide a computer to cockpit message for weather and air traffic messages. The system may also be utilized for automated ground based traffic advisory to provide aircraft separation assurance services in terminal areas. Mode S will provide improved quality surveillance data, by the elimination of interference, through the discrete addressing of aircraft. Improved airborne and airport operation through digital data link services will result in increases in air traffic controller productivity.

3.3.14.5 FLOW MANAGEMENT SYSTEM

This project element will provide a centralized Flow Management System for the dissemination of predicted and real-time flow restriction information and airspace reservation information. This information is required by airspace users in flight planning, air traffic control for adjusting in-flight profiles in order to minimize air traffic delays and to allow fuel efficient operations.

Based on the projected doubling of air traffic by the year 2000 and the fact that no new airports are planned for this period, flow management at busier locations will have to be implemented by 1995. The implementation of this system will permit strategic planning to be effected to reschedule air traffic and absorb delays in a more fuel efficient manner. The system will also handle Department of National Defense requirements for airspace and altitude reservation and will match these requiremens against the free flight or area navigation type profiles that will be the preference of airspace users.
Initial acitivity will be directed to the development of an airport capacity model capable of analyzing planned flight operations (arrivals and departures) in relation to airport (airside) capacities and forecasted weather conditions. When implemented, the Flow Management System will disseminate acceptance rate data for airports to the Area Control Centres to be used in organizing air traffic to accommodate delays through earlier (enroute) changes in flight profiles. Subsequent improvements to this system will allow the automatic transfer of information between flight planning systems of airlines, and with the FAA (United States). When the Advanced Integrated ATC System is achieved, the Flow Management System will provide information for the automatic determination of strategic clearances.

3.3.14.6 COMMON CONTROLLER WORKSTATION (SECTOR SUITE)

This project element provides an integrated and versatile Common Controller Workstation capable of being operated by one air traffic controller.

The sector suite will result in significantly increased air traffic controller productivity, and the combination of the central computer complex, distributed processing and partitioned software will provide increased system efficiency, reliability, and availability.

Common Controller Workstations will be developed which will provide air traffic controllers with electronic display of digital radar data, flight plan data, weather data, and supplementary aeronautical information. Down-sized versions of the Sector Suite (except for displays) will be provided in Towers, where daylight viewing displays will be used.

Air traffic situation displays (geographical and tabular), a planning and probe display, auxiliary displays and suitable interactive (touch input) devices will constitute the air traffic controller workstation. Each workstation suite will be capable of operating autonomously in the event of failure of the Central Computer Complex and distributed processing at each Sector Suite. This system performs radar data processing, flight data processing, aeronautical data management, and weather data processing. Multi-busses will carry data between the central computer complex and the sector suites.

In conjunction with development of the controller workstation, the software of the Central Computer Complex will be reorganized and redistributed to ensure that critical air traffic surveillance data will always be available at the workstation. The Central Computer Complex will be capable of expansion to accommodate future Air Traffic Control enhancements. Previous separate hardware systems (Radar Data Processing System, Flight Data Processing System, etc) will eventually evolve into this integrated complex thereby eliminating redundant activities and improving overall system performance.

3.3.14.7 ADVANCED INTEGRATED ATC SYSTEM

This project element provides for an integrated Air Traffic Control System which will permit aircraft to fly fuel efficient direct routes and increase system capacity and controller productivity.

In effect, this project will tie together all the Air Traffic Control systems and through the airground data link will allow automatic selection of flight profiles, automatic detection and resolution alternatives for conflicts, the delineation of restricted areas and hazardous weather, and the automatic issuance of clearances to aircraft.

During the mid 1990's, the Advanced Integrated ATC System will begin. Functions will be combined, which together with the Common Controller Workstation (Sector Suite), will provide the air traffic controller with automated aids for preparing and generating fuel-efficient, direct routing clearances. The next phase of integration will free the air traffic controller of the responsibility for time critical, moment-by-moment detection and resolution of conflicts, as these will be automatically initiated by the system. Finally, the system will be enhanced to automatically plan, generate, and deliver conflict free, fuel efficient clearances.

The Advanced Integrated ATC System will depend on realizing the implementation of:

- Data link capability (Mode S in radar coverage areas, High Frequency or Satellite in the Northern and Oceanic ares) for all aircraft operating above 18,000 feet and, in the high density traffic areas, down to 12,500 feet.
- The availability of real-time upper level wind and hazardous weather data in the central processing complexes of the Area Control Centres.
- The Flow Management System, integrated with the central processing complexes.

In this environment, the role of the air traffic controller will gradually change to that of a "system manager"

3.3.14.8 DATA LINK FOR DEPENDENT SURVEILLANCE

This project element will provide a dependent surveillance capability, and exchange of weather data to and from the aircraft, and transfer of clearances and flight plans on all suitably equipped aircraft operating in the low density traffic area and in the oceanec area.

In support of reducing operator costs and improved airspace utilization, Air Traffic Control management of traffic flows in the low density traffic area requires accurate and timely surveillance data. Because of the vast volume of airspace to be covered, traditional surveillance techniques (radar) are far too costly. The transfer of aircraft positional data, derived from their navigational systems, will provide the improved surveillance data for Air Traffic Control, and permit direct, fuel efficient, conflict free routings for users of the airspace. The data link exchange of weather information, clearances, and flight plans will also result in more efficient operations. Beginning in 1985, engineering development work will begin to explore avionics capabilities and accuracies, communications techniques and update rates and overall cost projections. Feasibility projects, in conjunction with airlines. will be conducted. Operational tests of the chosen system(s) will begin in 1987, with a target date of 1992 for first article implementation.

Satellite and High Frequency techniques will be explored for data link communications.

3.3.14.9 INTEGRATED INTRAFACILITY NETWORKS

This project element will provide Air Traffic Service facilities with cost effective, flexible, fault-tolerant intrafacility communications (voice and data) systems based on local area network concepts.

Because Air Traffic Service operational systems play a critical role in air safety, these intrafacility systems must be highly reliable both from the point of view of low numbers of equipment failures and high data integrity. The high cost of intrafacility systems also dictates that they be readily expandible thereby avoiding early obsolescence due to loading beyond the initial network capacity.

The inherent redundancy of local area networks employing distributed processing techniques should result in a more highly fault-tolerant system than previously possible with single or dual processor configurations. Because of the intrinsic modularity of distributed systems, expansion will be facilitated, permitting upgrading or additions.

Engineering development being conducted on distributed systems identified approaches for the implementation of reliable and flexible systems, based on local area networks.

As part of this investigation, an experimental local area network integrating both voice and data will be established to assess commercially available software with regards to its applicability to Air Traffic Service systems and to identify future software development needs. The concepts defined in the investigation phase will be proven through simulations on a prototype system. These engineering development activities are expected to continue until 1987.

Partial integration of these intrafacility networks into operational systems will begin in 1987. Full implementation in an evolutionary manner will continue through the turn of the century.

3.3.14.10 LOW LEVEL WIND SHEAR ALERT SYSTEM

This project element is designed to alert the pilot, through the local tower controller, of the probability of hazardous wind shear on final approach. Certain airports are more severely affected by frontal and thunderstorm activity that generate wind shears with extreme velocities. Installation of a wind shear alerting system will ensure pilots are alerted to this hazzard. Information from ideally sited wind measurement devices connected through processors will detect and alert controllers to wind shears.

3.3.14.11 LOW LEVEL VORTEX WARNING ALERT SYSTEM

To detect the presence of wake vortices and provide this information to air traffic controllers in order that the larger longitudinal separations required when light aircraft follow heavy jet aircraft need be applied only when necessary, thereby optimizing runway capacity. Safe separation is predicated on decay or disperson of vortices, therefore the installation of an Low Level Vortex Warning Alert System will detect the presence of a vortex and aid the air traffic controller in determining safe but optimal separations for aircraft on approach or takeoff.

Engineering development will be undertaken to design and test feasibility of wake vortex measurement and prediction. Current work in the United States will be monitored closely and joint development considered to adapt measurement techniques to Canadian environment.

3.3.14.12 VLF STATIONS

This project element provides enhanced Omega navigation coverage and accuracy in Canada and in particular in the low density traffic area. The worldwide coverage provided by Omega is not adequate in North Central Canada due to propagation and geometry constraints. It is planned to supplement this with dedicated Very Low Frequency stations in order to provide a reliable low cost wide area naviation system.

A feasibility study will be conducted to determine the minimum cost solution in terms of the number of stations required, power and voltage volume, location, etc. Contracts will be awarded for the design, equipment fabrication, and installation of the required stations.

3.3.14.13 DIFFERENTIAL OMEGA

This project element provides for the development of the design and the equipment required to provide an enhanced Omega accuracy within 150 Km of a selected location through the use of differential techniques. It also involves the installation of this equipment at selected Non-Directional Beacon sites within the low density traffic areas.

Existing engineering development work will continue to refine and demonstrate the capabilties of Differential Omega. Contracts will be awarded for the procurement of suitable ground equipment and airborne equipment manufacturers will be encouraged to produce the necessary airborne components. Installations will be carried out at selected locations in consultation with the aviation community.

3.3.14.14 AIRPORT SURFACE NAVIGATION

This project element is design to provide an independent accurate surface navigation system for the movement of aircraft and ground vehicles operating on the manuevering area of the airport during low visibility conditions. To fully exploit the benefits of Category III installations for landing under zero visibility conditions it will be necessary to have the capability of deploying fire, rescue, and snow vehicles as well as providing aircraft navigation information under these conditions.

Engineering development will be carried out to test and demonstrate feasibility of a proposed system. Contracts will be issued and installations carried out in conformity with Category III precision approach facilities. Onboard equipment requirements will be considered as part of the system development.

3.3.14.15 SATELLITE DERIVED ENROUTE NAVIGATION, COMMUNICATIONS AND SURVEILLANCE

To carry out engineering development work on satellite systems in cooperation with other countries in order to establish future system designs. To determine the feasibility of providing navigation, communications and surveillance from a common satellite system.

Studies will be carried out in conjunction with other countries to examine existing satellite navigation and communications satellite systems including NAVSTAR, INMARSAT, etc. The potential for combining requirements for navigation, communications, and surveillance in one domestic civil aeronautical satellite for use in the North American environment will be explored with the United States.

3.3.14.16 TECHNICAL SYSTEMS CENTRE

To establish a Technical Systems Centre to provide the necessary laboratory and office space to accommodate the growth in technical support needs of the Canadian Airspace System.

The need to provide engineering support, configuration management, and to develop new procedures to accommodate the growth in systems will require more space than currently exists in the Engineering Systems Laboratory, the DMC, and the Research and Experimentation Centre. At the present time these facilities provide a combined total of 5,500 square meters of laboratory space for a requirement of some 8,000 square meters by 1988. Expansion and consolidation of the currently distributed facilities into a single establishment, the Technical Systems Centre will ensure future laboratory and office space requirements are met and enable common services and equipment to be shared and used more efficiently and effectively.

The projected requirements are for a net usable floor space comprising 5,800 square meters of laboratory space and 2,200 square meters of office space.

During the ongoing implementation of the Canadian Airspace Systems Plan, advanced technology and concepts must be developed and explored for future integration into the Canadian Airspace System. These studies and developments conducted at the Technical Systems Centre should include facilities for development of hardware and software changes to the operational systems, technical support of field personnel, and operational testing and evaluation of new systems. National field engineering support for all hardware and software systems will be provided by a team of technical experts from the Technical Systems Centre.

A project to expand the facilities at the Technical Systems Centre is currently underway, however, the program should be expanded to include consolidation of all research and experimentation facilities into one single establishment.

Many of the projects in the Canadian Airspace Systems Plan are in the requirements and definition stage and will require substantial engineering development and integration testing prior to implementation into the Canadian Airspace System.

The following table depicts: 1) The current status of identifying resources for this project; 2) The project elements assigned to this Major Project in the "bundling" process (accumulation of the most interrelated and interdependent projects); and 3) The projects and/or subprojects currently residing in other organizational entities that should be transferred to this project.

DEVELOPMENT

OVERALL RESOURCES

Capital cost data including the number of capital person years are currently in the planning and formulation stage.

PROJECT ELEMENTS

PROJECT ELEMENTS	CASP PAGE REFERENCE
RADAR/AUTOMATION	
CONFLICT PREDICTION AND MINIMUM SAFE ALTITUDE WARNING	3-30
CONFLICT RESOLUTION ADVISORY	3-32
METERING AND SEQUENCING	3-34
MODE S DATA LINK UPGRADE	6-72
FLOW MANAGEMENT SYSTEM	3-38
ADVANCED INTEGRATED ATC SYSTEM	3-40
COMMON CONTROLLER WORK STATION	3-36
NAVIGATION:	
LOW LEVEL WIND SHEAR ALERT SYSTEM	5-14
LOW LEVEL VORTEX WARNING ALERT SYSTEM	5-16
AIRPORTS SURFACE NAVIGATION	6-64
VLF STATIONS	6-54
DIFFERENTIAL OMEGA	6-56
COMMUNICATIONS:	
DATA LINK FOR DEPENDENT SURVEILLANCE	6-46
INTEGRATED INTRAFACILITY NETWORKS	7-22
SATELLITE DERIVED ENROUTE NAVIGATION, COMMUNICATIONS, AND SURVEILLANCE	6-76
SYSTEM ENGINEERING:	
TECHNICAL SYSTEMS CENTRE	8-22

PROJECTS AND SUBPROJECTS TO BE TRANSFERRED TO THIS PROJECT

CURRENT PROJECT OR SUBPROJECT ELEMENTS	CURRENT APPROVED OR ESTIMATED FUNDS	PROJECT NUMBER	PAD/CMR
NAVIGATION			
Omega VLF Navigation Evaluation	32,000	S2-H126-4013	CMR
	11,000	N2-H126-4013	CMR
	43,000		
COMMUNICATIONS			
Application of Satellites	436,400	S2-H125-5023	PAD
SYSTEM ENGINEERING			
Lab Computer Replacement	621,000	S2-H122-0007	PAD CMR
Equipment For Laboratory	98,000	S2-H122-0011	CMR
Milling Machine For Lab	20,000	S2-H122-0012	CMR
Cleansing Air System	30,000	S2-H122-0013	CMR
Improvements BW&L	5,000	S2-H122-2012	CMR
Exp & Equip Telecom Lab	50,000	S2-H122-2014	CMR
Procure Elect Test Equip	25,000	S2-H122-4011	CMR
	849,000		

As earlier described, the "bundling" of interrelated and interdependent projects was designed to 1) best use scarce, and sometimes unavailable, resources by increasing project and subproject level responsibilities, 2) decrease the amount of documentation required for each project and subproject by establishing a single document for each Major Project (i.e. Approval in Principal Documents, and Project Approval Documents, etc.), and 3) to permit establishment of a Program Management structure and systems engineering function to more efficiently oversee and ensure implementation of the Canadian Airspace Systems Plan. The latter will be done in very close coordination and support of other Canadian Air Transportation Administration organizational requirements, i.e. as defined by the Air Navigation Requirements Branch and the Air Traffic Services Branch.

"Bundling" like and interdependent projects into Major Projects, as depicted in Figure 3-4, and treating the entire Canadian Airspace Systems Plan as the Program serves a number of purposes.

It invites a broader design perspective in which the entire activity can be addressed as a unity. That orientation will inevitably result in fewer interface problems as projects mature and result in a lower overall Program cost.

It will significantly reduce the number of Project Approval Documents required (and the associated paperwork) which in turn frees up those person years for other productive work. Additionally, a reduction of the number of Project Approval Documents to something on the order of 12-15 covering the entire Plan will permit (by getting the Project Approval Documents approved) upgrading the status of the Plan from a planning document to a programming document. As such it will become the sole basis on which projects could be included in the Main Estimates or the Multi-Year Operations Plan (i.e. a project would have to be included in the approved program before it could be included in a budget or on the Current Year Priority List). At the same time, the existing procedures for amending Project Approval Documents will assure a continued degree of flexibility for introducing changes into the Program while at the same time assuring an appropriate level of discipline for introducing those changes.

While the foregoing are good and sufficient reasons for "bundling" interrelated and interdependent projects into Major Projects, there is still another reason for doing so. It permits the establishment of a Program Management Structure which will provide maximum control of the Program Planning and System Integration processes. That structure and its associated management support systems are described in the next section.

3.4 SYSTEM ENGINEERINNG MANAGEMENT AND SUPPORTING SYSTEMS

3.4.1 GENERAL

In previous sections we described the application of System Engineering Process to the implementation of the Canadian Airspace Systems Plan and the "bundling" of similar or interdependent projects into Major Projects. The Canadian Airspace Systems Plan was defined as The Program. At the next level Major Projects were defined and projects within Major Projects were identified. The overriding motivation, of course, being the need and desire to maximize the productivity of the work force and to realize some early benefits from implementation of the Canadian Airspace Systems Plan. Implementation of the notions outlined in the previous sections will result in some significant changes in the way in which the Canadian Air Transportation Administration does business. This section will describe an approach to Program Management which is designed to provide maximum control of those changing processes. It will further describe a number of systems required (in terms of both hardware and software) to support internal management of the Program and provide the ability and means for upward reporting of Program status.

The Program Management Structure and concepts described here, together with the appropriate management support systems, will buttress management in what is unquestionably the largest and most complex activity ever undertaken by the Canadian Air Transportation Administration.

In general the Program Management structure required is one in which each individual contract is managed independently of all other contracts, each project is managed independently of all other projects, and each Major Project is managed independently of all other Major Projects. The foregoing situation exists so long as a set of carefully predetermined "boundary values" are not affected. That is to say that each contract, project, or Major Project operates independently so long as it does not impinge or impact any other contract, project, or Major Project. Of course we know that inevitably boundary values will be affected and adjustments will have to be made. It is the function of management (at whichever level) to assure that in such situations, the maximum degree of synergism is realized.

In describing the program hierarchy structure we will begin with the most familiar (project management) and build on that through Major Project Management and then to Program Management where the Systems Engineering function should reside.

3.4.2 CANADIAN AIRSPACE SYSTEMS PLAN PROGRAM MANAGEMENT STRUCTURE

3.4.2.1 PROJECT MANAGEMENT

In the planning process various levels of Operational Service Requirements were defined and addressed by the various levels of Operational Performance Requirements which in turn were addressed by various levels of System Designs. System Design Levels I and II, previously described, established a set of inputs and outputs for each individual project (or activity) and a schedule (i.e. described by System Design Level III, intermediate states). System Design Level IV was the specific design of each facility at each of the design level III "windows". Of course the cost parameters for each project are defined in the approved budget. It is within that rather carefully defined framework that each project is managed independently of all others. So long as (1) the agreed upon inputs are accommodated and the outputs delivered, (2) cost projections are met, and (3) project schedules are maintained, the project engineer is free to operate independently.

Within this carefully defined framework, Project Engineers are responsible for the technical and administrative performance of the project. They are responsible for making their own configuration control decisions and maintaining configuration control of their projects. They must of course do this in accordance with the Canadian Air Transportation Administration's prescribed process. Project engineers are also responsible for cost and schedule performance of their projects. The upward reporting is to the Major Project Manager. While the Project Engineer is expected to be on top of all details of the project, upward reporting should generally (except in the case of a problem) be limited to general project status (i.e. major milestones) and those things which may affect a project "boundary value" such as input or output, cost, or schedule. This arrangement is depicted in Figure 3-5.

At the project level, schedule management provides the basis for and the means by which the Project Engineer measures actual progress of contracts supporting the project and of the project itself against previously agreed to schedules. It is a vehicle which allows the Project Engineer to anticipate delays, determine the causal factors of those delays, and intiate prompt remedial action to mitigate them. It facilitates effective communications within the program, with contractors supporting the program, and with higher levels of management.

Cost parameters for each project are rather specifically defined in the approved budget. Planning monitoring and control of costs at the project level and for individual contracts and contract milestones is imperative to assure the fiscal integrity of the project and its fidelity with the approved budget.

Each project is typically composed of a series of subprojects and contracts each with their own predefined boundary values. Configuration control at the project level is required 1) to insure that none of those boundary values are changed without analyzing and accommodating the impact of such a change on other elements of the project; 2) to provide the current status (in terms of configuration) of each configuration item; and 3) to standardize and document the final configuration of each like configuration item. Such standardizations permit maintenance to be standardized, facilitate maintenance training, facilitate operator training, and permit approved modifications to be uniformly implemented on like configuration items with the same, predictable, result.

PROJECT MANAGEMENT STRUCTURE

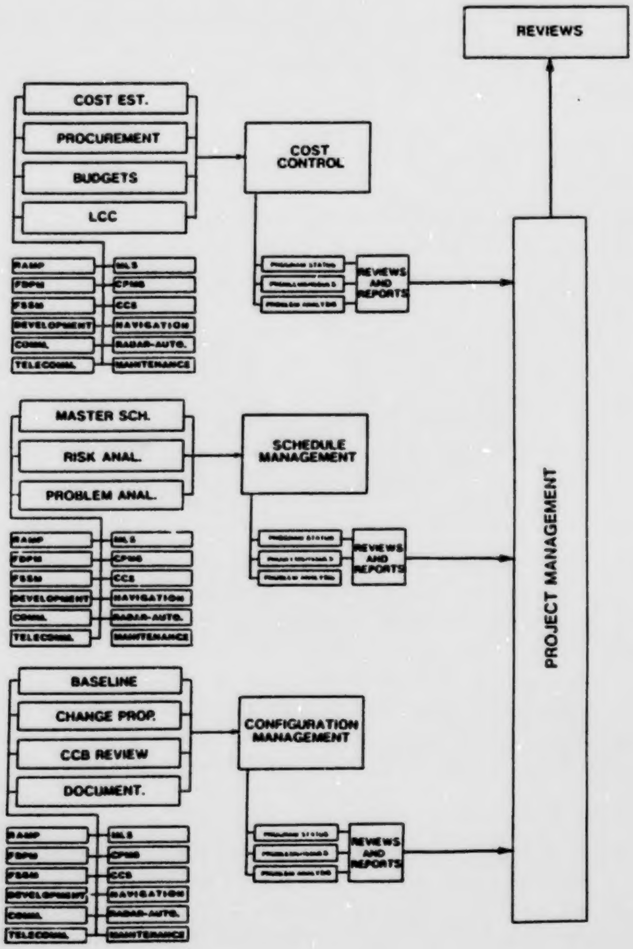

REVIEWS
COST EST.
PROCUREMENT
BUDGETS
LCC
COST CONTROL
RAMP
DEVELOPMENT
COMM.
TELECOMM.
MLS
CCS
NAVIGATION
RADAR-AUTO.
MAINTENANCE
REVIEWS AND REPORTS
MASTER SCH.
RISK ANAL.
PROBLEM ANAL.
SCHEDULE MANAGEMENT
RAMP
DEVELOPMENT
COMM.
TELECOMM.
MLS
CCS
NAVIGATION
RADAR-AUTO.
MAINTENANCE
REVIEWS AND REPORTS
BASELINE
CHANGE PROP.
CCB REVIEW
DOCUMENT.
CONFIGURATION MANAGEMENT
RAMP
DEVELOPMENT
COMM.
TELECOMM.
MLS
CCS
NAVIGATION
RADAR-AUTO.
MAINTENANCE
REVIEWS AND REPORTS
PROJECT MANAGEMENT

FIGURE 3—5

3.4.2.2 MAJOR PROJECT MANAGEMENT

Very much the same situation prevails at the Major Project level, only in the context of the Major Project which is normally an aggregation of individual projects. The Major Project Manager is responsible for the technical performance of the aggregation of the individual projects comprising the Major Project. The Major Project Manager is free to make schedule, cost, and configuration tradeoffs between individual projects within the Major Project without recourse to higher authority. It is only when those tradeoffs impinge on another Major Project that recourse to the Program Manager is necessary. (It is of course recognized that Major Crown Projects would introduce a slight purtabation to the process). At the Major Project level another concern is introduced. That is benefit asssurance which is measurement and validation that the benefits expected to be accrued as the result of performing the Major Project are in fact materializing as predicted. It could be argued that this activity is also appropriate at the individual project level. In some few cases that is true and in those cases the Project Engineer should be performing the function also. In general however, it is a group of projects which produce a benefit, not an individual project. Two cases in point are Data Link and Remote Maintenance Monitoring. Neither is intrinsically cost beneficial. Their real worth is in allowing the introduction of other extremely cost beneficial projects or capabilities which could not otherwise be introduced. Upward reporting is to the Program Manager. Upward reporting would generally (except in the case of a problem) be limited to Major Project status (i.e. major milestones) and those things which may affect the Major Projects "boundary values" such as cost, schedule, configuration, and benefit assurance. This arrangement is depicted in Figure 3-6.

Schedule management, cost control, and configuration management at the Major Project level involves the same concerns and processes and are performed for all the same reasons as described for individual projects. The difference is that these activities are performed in the context of the Major Project viz-a-viz the aggregation of projects which support it rather than in the context of the project viz-a-viz the subprojects and contracts which support it.

An added feature at the Major Project level is the addition of a benefit assurance function. Benefit assurance is the periodic examination of the Major Project to insure that actual benefits have materialized, are materializing, or are still expected to materialize as originally projected. A variation of benefit assurance, which is also a concern to the Major Project Manager is cost-benefit assurance. A cost-benefit analysis is prepared for each Major Project as a part of the approval process by the Canadian Air Transportation Administration's Economic Analysis and Evaluation Division. Cost benefit assurance in the context of the Major Project involves a periodic check to ensure that the cost-benefit analysis on which the project was originally predicated remains valid. the aim of this periodic review is to confirm to Major Project Managers (and other higher levels of management) that the original cost-benefit basis on which the project was funded continues to be realistic or alternatively to alert them to initiate corrective action. Such corrective actions can be on either the cost side or the benefit side of the equation.

MAJOR PROJECT MANAGEMENT STRUCTURE

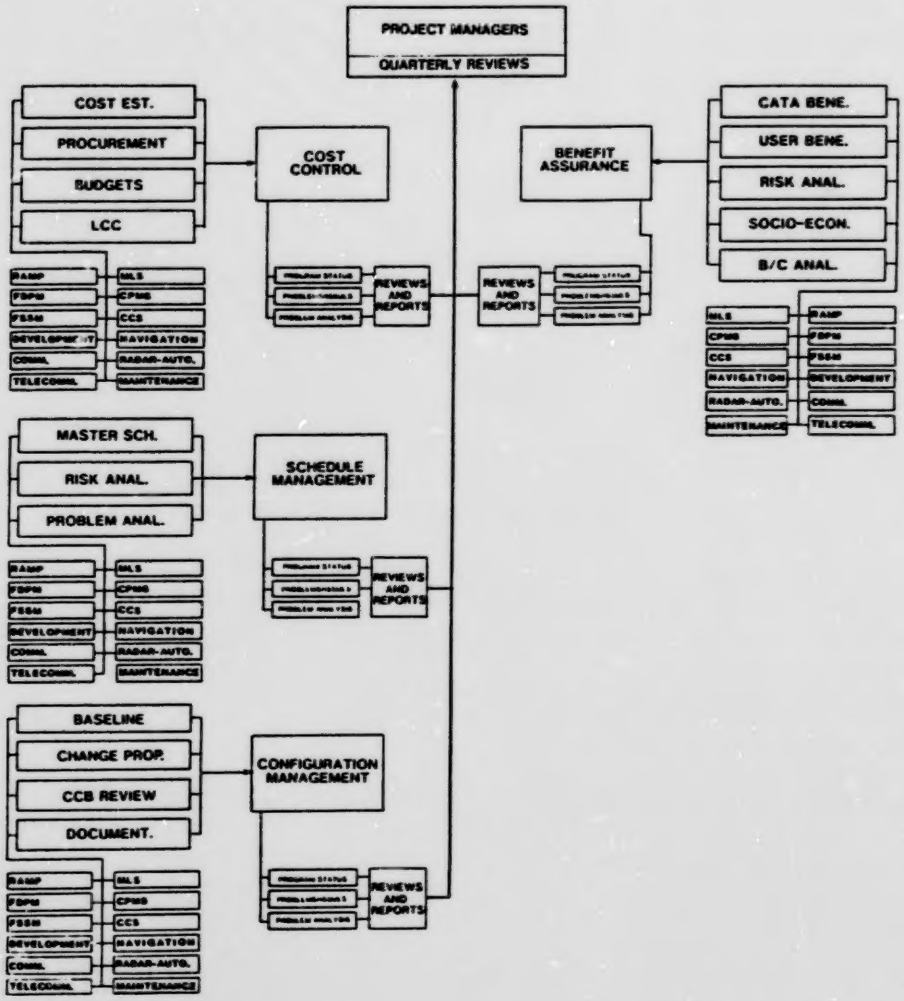

PROJECT MANAGERS
QUARTERLY REVIEWS
COST EST.
PROCUREMENT
BUDGETS
LCC
COST CONTROL
RAMP
FDPM
FSSM
DEVELOPMENT
COMM.
TELECOMM.
MLS
CPMS
CCS
NAVIGATION
RADAR-AUTO.
MAINTENANCE
REVIEWS AND REPORTS
BENEFIT ASSURANCE
CATA BENE.
USER BENE.
RISK ANAL.
SOCIO-ECON.
B/C ANAL.
MASTER SCH.
RISK ANAL.
PROBLEM ANAL.
SCHEDULE MANAGEMENT
BASELINE
CHANGE PROP.
CCB REVIEW
DOCUMENT.
CONFIGURATION MANAGEMENT

FIGURE 3—6

3.4.2.3 PROGRAM MANAGEMENT

At the Program Management level, the situation is again very much the same. The Program Manager is responsible for the technical performance of the entire program. The Program Manager may make cost, schedule, and configuration changes between Major Projects. The Program Manager is also concerned with benefit assurance of the total program - benefits which should be greater than the sum of the benefits expected or realized by the Major Projects. An additional concern at this level is project performance analysis.

Schedule management, cost control, and configuration management at the total Program Management level involves the same concerns and processes and are performed for all the same reasons as described for individual projects. The difference is that they are performed at the Program Management level viz-a-viz the Major Project rather than at the more detailed levels described for the Major Projects and projects.

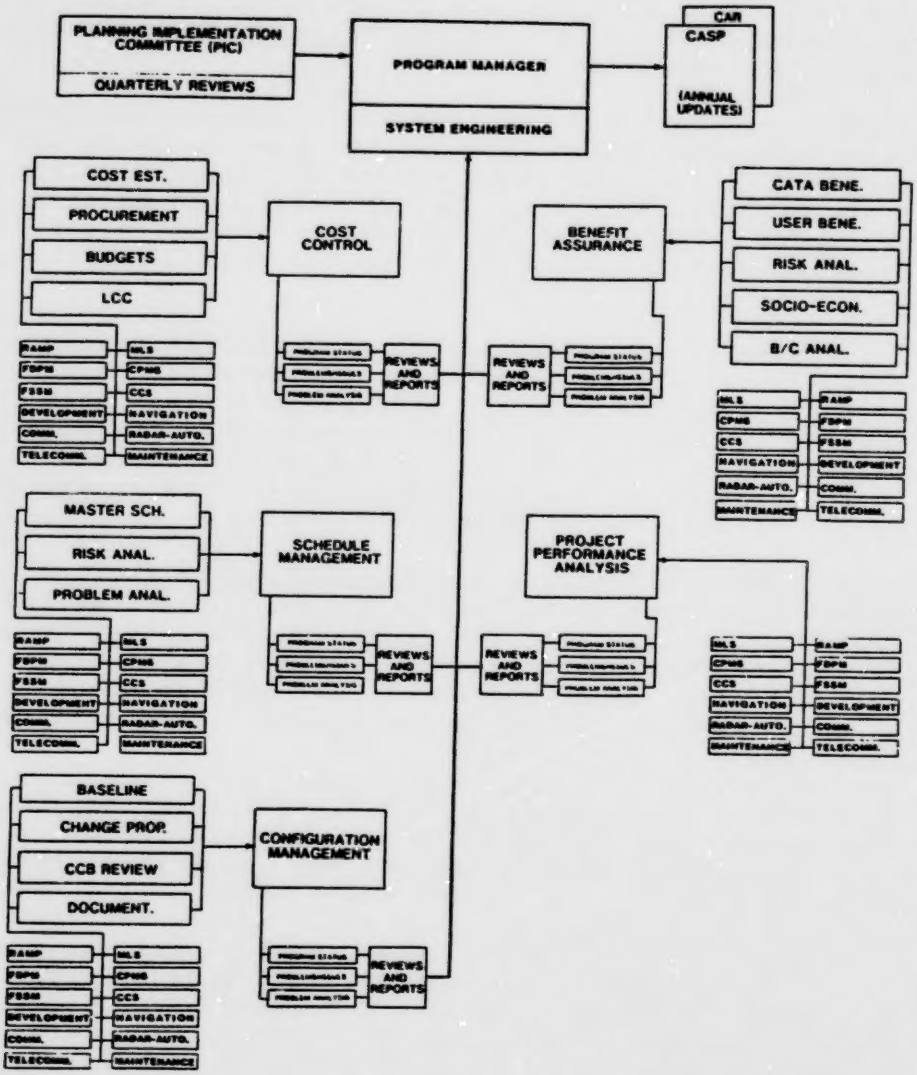
Similarly, the benefit assurance and cost-benefit assurance activities at the Program Management level involves the same processes as described for the Major Projects. Again, the difference is that they are performed in the context of the Program rather than the Major Project. In that context the benefits of the total program, through the synergistic interaction of the Major Projects should exceed the sum of the benefits of the individual Major Projects.

Assuring that the Major Projects are interacting in a manner which achieves the maximum synergistic effect is the concern of the Project Performance Analysis activity. This activity consist of ongoing analysis of the interactions between projects and a continuing assessment of the efficacy of the functional allocation of requirements which occurred in Level I and II System Design. This arrangement is depicted in Figure 3-7.

It is at this level, i.e. the Program Manager level, that the Systems Engineering activity must operate. Cost Control, Schedule Management, Configuration Management, Benefit Assurance, and Project Performance Analysis all come together in Systems Engineering. It is here where tradeoffs between Major Projects are made to assure that the total Program remains in balance, on schedule, and produces the desired benefits. This is in addition to the System Design efforts which are part of the Systems Engineering effort described earlier. The Systems Engineering activity must also orchestrate the Systems Integration and Operational Testing activities and assure that fielded systems perform as planned.

It is here too, that the Planning and Implementation Committee comes into play.

PROGRAM MANAGEMENT STRUCTURE



PLANNING IMPLEMENTATION COMMITTEE (PIC)
QUARTERLY REVIEWS
PROGRAM MANAGER
SYSTEM ENGINEERING
CAR
CASP
(ANNUAL UPDATES)
COST EST.
PROCUREMENT
BUDGETS
LCC
COST CONTROL
RAMP
FDPM
FSSM
DEVELOPMENT
COMM.
TELECOMM.
MLS
CPMS
CCS
NAVIGATION
RADAR-AUTO.
MAINTENANCE
REVIEWS AND REPORTS
BENEFIT ASSURANCE
CATA BENE.
USER BENE.
RISK ANAL.
SOCIO-ECON.
B/C ANAL.
MASTER SCH.
RISK ANAL.
PROBLEM ANAL.
SCHEDULE MANAGEMENT
PROJECT PERFORMANCE ANALYSIS
BASELINE
CHANGE PROP.
CCB REVIEW
DOCUMENT.
CONFIGURATION MANAGEMENT

FIGURE 3–7

3.4.2.4 HIERARCHICAL PROGRAM MANAGEMENT STRUCTURE

What we have then is a Program Hierarchy where the entire Canadian Airspace Systems Plan is defined as the total program with an individual (appropriately supported by staff) responsible for accomplishment of the entire program.

This would involve planning, organizing, directing, coordinating, and reviewing the various Major Projects which when taken collectively constitute the Canadian Airspace Systems Plan. At the next level we have Major Project Managers who do precisely the same things with respect to the individual projects which when taken collectively constitute each Major Project. At the next level we find Project Engineers who again do precisely the same things with respect to the various activities which when taken collectively constitute a project. This hierarchial relationship is depicted in Figure 3-8.

3.4.3 CANADIAN AIRSPACE SYSTEMS PLAN MANAGEMENT SUPPORT SYSTEMS

3.4.3.1 GENERAL

A range of support tools are required to support planning and execution of the Canadian Airspace Systems Plan and its management. These tools form an integral part of the management processes identified in previous sections of this document. Since tools must be adapted to the processes they serve, and since processes are themselves adapted to the style and aims of the organizations they serve, it follows that support tools chosen must relate intimately to the Canadian Air Transportation Administration's processes and management approach. Given this, several key considerations emerge that have guided the selection of these tools. These are as follows:

- o support tools must be simple to understand and use;
- o they should explicitly recognize and complement the Program, Major Project, project, and sub-project/contract hierarchy;
- o they must not require high standards of computer literacy, nor must they rely on the services of a highly qualified functional staff group;
- o there is an immediate and a long-term requirement.

In what follows, the ramifications of each of the requirements are outlined.

3.4.3.1.1 SIMPLICITY

Notwithstanding the desire to retain the element of simplicity in the choice of tools, the processes to which they are addressed are not themselves simple. Within the bounds of process exigencies however, the goal of simplicity has been pursued through modularity. Thus, whenever possible, support tools have been selected for their ability to operate fully independently.

3.4.3.1.2 COMPLEMENT THE MANAGEMENT HIERARCHY

This requirement is explicitly recognized for each support tool and follows a scheme whereby information flow between levels of the hierarchy occurs whenever there is a need for roll-up or summary data to portray the Program as a whole or where an event or change at one point in the hierarchy leads to repercussions outside the span of control covered at that point. In such cases, information flows upwards to a higher level.

3.4.3.1.3 NOT REQUIRE HIGH LEVELS OF COMPUTER LITERACY OR SPECIALIZED STAFF SUPPORT

This need has been translated to a bias in the direction of stand-alone micro-computer hardware and a strong requirement that software exhibit user friendliness, at the expense, if necessary, of enhanced capability. It is acknowledged that main-frame systems need not necessarily sacrifice user friendliness for greater capability, however, it is a simple fact that greater capability necessarily entails greater complexity. A glance at user guides for mainframe versus micro-based packages for similar applications will confirm this.

3.4.3.1.4 MEDIUM AND LONG TERM REQUIREMENTS

Tools are needed now to capture existing projects as well as the ever increasing levels of Program activity. To define and acquire an ultimate system whose requirements are as yet not fully determined, would introduce a serious delay. Instead, the emphasis should be on what can be put in hand relatively quickly, with the understanding that it can evolve over time into greater sophistication.

In all cases, support tools are aimed at acquiring, storing, manipulating, and retrieving information. Where there is a heavy emphasis on the storage and retrieval functions and a number of users are involved, centralized storage facilities and/or a sophisticated communications capability are important. Where the emphasis is on data manipulation unique to a particular user, the need for centralized data storage and sophisticated communications is reduced. We believe that all but two of the support needs identified can be addressed using a stand-alone network, with a basic data communications capability.

In what follows, various support tools are described. A background description of the processes within which they are intended to operate is provided in Appendix A.

3.4.3.2 SCHEDULE, COST CONTROL, AND ALLOCATION SYSTEM

The schedule, cost control, and allocation system incorporates three distinct but connected components -- one for planning, monitoring and controlling the Program/project schedule (the schedule control component), a second for planning, monitoring and controlling costs (the cost control component), and a third for resource allocation. Because these three components are very closely connected, it is convenient to deal with them together as far as possible. In what follows the requirements for each component are dealt with separately, while systems to meet these requirements are outlined for all three together.

3.4.3.2.1 SCHEDULE PLANNING, MONITORING, AND CONTROL REQUIREMENTS

Management of the Canadian Airspace Systems Plan Program will involve the planning, monitoring, and control of a large number of interdependent activities. As a basis for doing this, a formal planning and progress monitoring system is required. Such a system portrays the timing and interrelationships of all planned activities, identifies activities whose completion is critical to timely completion of the project, allows progress to be recorded against the Plan, and displays Plan, progress, and plan changes in a clear, easy to follow manner.

Such a system enables managers to measure overall progress, to anticipate delays, to trace the sources of delays, and to communicate more effectively both within the Program and with project contractors.

Managers require the following schedule information as a basis for planning, monitoring, and control:

- a work breakdown structure showing the organization of the overall Program into distinct components;
- activity plan (for the Program, Major Projects, projects, and subprojects/contracts) showing plans by day, week, or month as appropriate;
- activity start and completion dates for each network;
- activity duration for each network;
- float showing for each activity the amount of time by which it can be delayed without delaying the overall project, for each network;
- progress agains the plan (for the Program, Major Projects, projects, and subprojects/contracts) showing actual or estimated time to complete;
- responsibility allocations (for the Program, Major Projects, projects, and subprojects/contracts) among organizational units.

In addition there is a need to present plans and progress information in an easy to follow graphical format.

3.4.3.2.2 COST PLANNING, MONITORING, AND CONTROL REQUIREMENTS

Management of the Canadian Airspace Systems Plan Program will involve the planning, monitoring, and control of costs for the Program, Major Projects, projects, individual contracts, and contract milestones. In order to achieve this, a cost control process is required.

Information required to support this process is as follows:

- forecast (by Program, Major Project, and project)*;
- Project Approval Document approvals (by Program, Major Project, and project)*;
- delegation (by Program, Major Project, and project)*;
- commitments (by Program, Major Project, project, and contract)*;
- value of work completed (by Program, Major Project, project, and contract)*;
- invoiced amounts (by Program, Major Project, project, and contract);
- cash allocation (by Program, Major Project, project, and contract);
- expenditures (by Program, Major Project, project, and contract)*.

Items asterisked are required by fiscal year both for each year and cumulatively. All but the second item in the list are required by month. In addition, information is required on variances between planned and actuals as well as for plan changes. Finally, there is a need to display this information graphically.

3.4.3.2.3 RESOURCE ALLOCATION REQUIREMENTS

Project activities draw upon resources of manpower, money, materials, and facilities. Without concerted planning, the usage pattern for a given resource over time is likely to be uneven. Peaks and troughs in resource usage can sometimes be "ironed out" by altering the schedule -- delaying some activities and/or bringing others forward. The effect of such schedule adjustments may be to delay the overall project. Required, is a process to minimize this delay.

Information required to support the allocation function is as follows:

- resource profile showing units of resource required versus time;
- resource utilization summary showing total units of a resource utilized for the network;
- resource activity report showing for each activity the resource inputs required.

3.4.3.2.4 RECOMMENDED SYSTEM

A loosely coupled network of personal computers is recommended for support of the package of program management tools:

- Master Schedule System
- Cost Control System
- Allocation System

Each node of the network (Figure 3-9) will consist of an identical configuration of equipment. Any node will be able to transfer or receive data from any other node by means of a data transfer over the telephone network. In cases where the physical distance between the nodes is small and in the same building, these data may also be exchanged by diskette.

PROPOSED SYSTEM CONFIGURATION

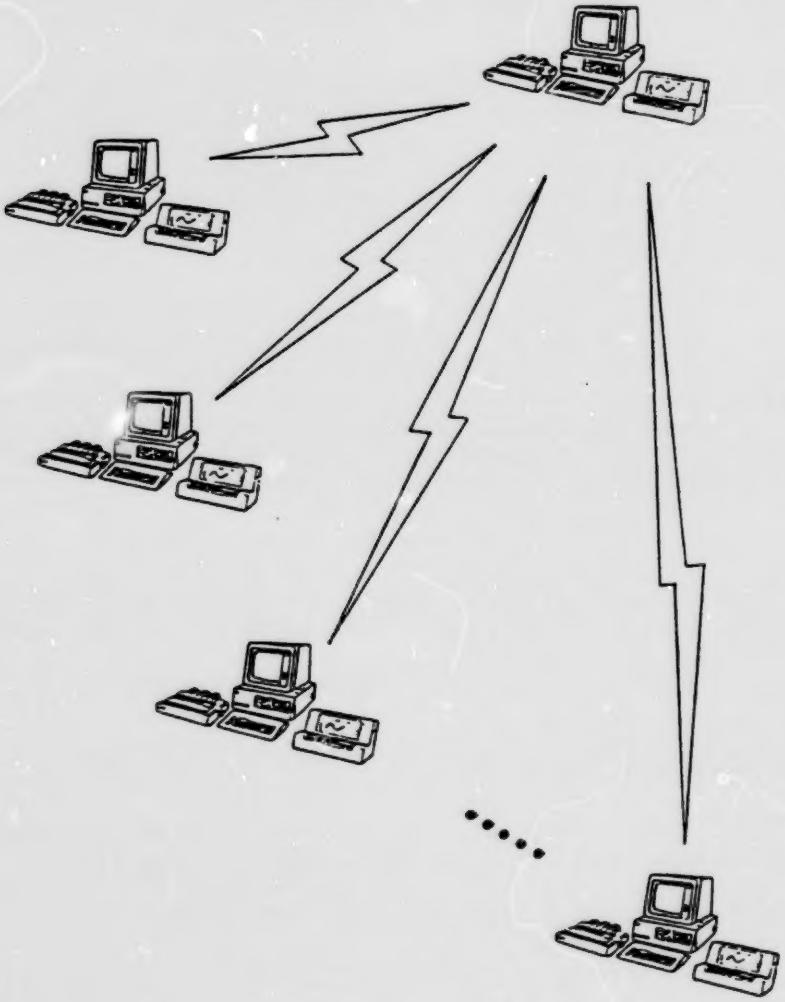


FIGURE 3—9

This proposed solution is more expensive than other options (local area networks or mainframe based multi-user systems) due to the need for duplication of some hardware and software. This disadvantage, however, is outweighed by the following:

- o Reliability of equipment through multiple redundant hardware;
- o Availability of the system to support other local applications with the addition of extra software;
- o Servicability of the system by virtue of its modularity and functional independence from other nodes;
- o Off-the-shelf equipment availability, no special environmental requirements, and simple installation procedures;
- o Relative ease of operation.

Accordingly, we recommend adoption of the PROMIS system along with the acquisition of stand alone hardware in the form of an IBM PC (XT) and graphics plotter at each work station. See Figure 3-10 and Table 3-1 which follows for details of the proposed hardware configuration, software, and estimated costs. The number of work stations required will depend mainly on the physical proximity of managers. Where managers share adjoining premises, each work station can easily serve up to four managers. Managers at remote sites should be given access to their own facilities on site.

Included with each work station configuration is the hardware and software needed to enable data transmission to another work station. This will allow for the computer to transmit the data needed for rollup from contractors through project and Major Project to Program.

INDIVIDUAL WORK STATION

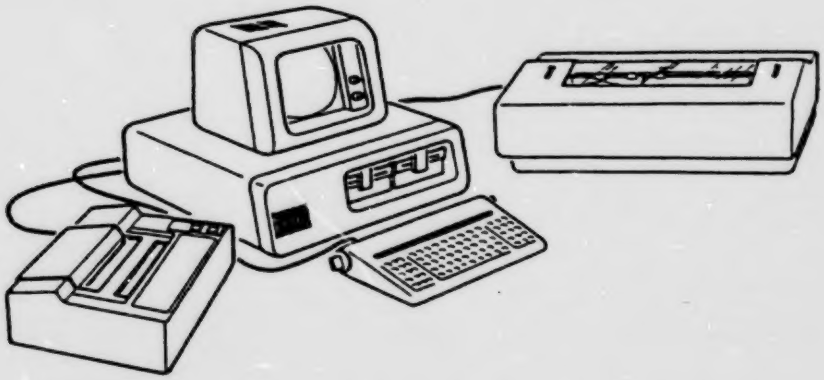


FIGURE 3—10

ESTIMATED HARDWARE/SOFTWARE COSTS

HARDWARE COMPONENT		LIST PRICE
IBM-COMPATIBLE PERSONAL COMPUTER; 512K BYTES STORAGE; 10MB HARD DISK; DISKETTE DRIVE; SERIAL AND PARALLEL (2) PORTS; MONOCHROME DISPLAY (IBM PC-XT)		$ 7,400.00
160 CPS DOT MATRIX PRINTER, 132 COLUMNS (EPSON FX100)		1,200.00
1200 BPS AUTO ANSWER MODEM (HAYES SMARTMODEM)		400.00
	HARDWARE SUBTOTAL	$ 9,000.00
SOFTWARE COMPONENT		**LIST PRICE**
PROMTS		$ 3,200.00
PC-DOS OPERATING SYSTEM		75.00
SMARTCOM II		150.00
LOTUS 1-2-3		500.00
	SOFTWARE SUBTOTAL	$ 3,925.00
	TOTAL	$12,925.00

TABLE 3-1

3.4.3.3 CONFIGURATION MANAGEMENT

3.4.3.3.1 REQUIREMENT

Hardware and software development and implementation is an evolutionary activity that involves the continuing creation of new versions of programs, hardware, and associated documentation.

Without a comprehensive method for ensuring that changes are properly approved, implemented, and documented, a multitude of complications ensue. Hardware and software gradually take on a variety of distinct characteristics. Approved modifications cannot be uniformly implemented. Hardware and software baselines become outdated. Change information resides in the minds of key individuals, the risk of error increases, and staff changes can create serious difficulties in continuity of service.

Required is a system for accounting and identifying the configuration of key hardware and software and their associated documentation. Such a system should incorporate provision for the following:

- configuration identification;
- change control procedures;
- status accounting; and
- quality assurance.

Status report of Change Proposals in process (prior to approval) contains a list, by equipment type, of all outstanding Change Proposals showing approvals received and the dates of those approvals.

Under the Canadian Air Transportation Administration's existing system, some reports of these types are produced some of the time. There is no overall system requirements within the Canadian Air Transportation Administration that would ensure that this information, or a designated subset of it, is available for all Configuration Identifications all of the time.

3.4.3.3.2 CONFIGURATION MANGEMENT SUPPORT TOOLS

A sophisticated range of associative database applications are available to support both Configuration Management and maintenance management on an "on-line" basis. These systems offer "on-line" configuration status, maintenance status, change control and tracking, and maintenance work order control and tracking.

Older Configuration Management systems, typically offer similar features but are not "on-line", do not allow flexibility in specifying output reports, and are not user friendly. Unfortunately, many manufacturers are wedded to these "second generation" systems. The reason is that these systems were introduced some time ago, they fit well with other systems the manufacturers use, and their staff are familiar with those systems. Most major computer manufacturers offer packages that in effect support Configuration Management in a manufacturing environment (although the tools often have other names such as MFG/PLUS (Control Data), Material Requirements Planning (IBM), and TRMS used by Martin Marietta. These systems are designed to meet individual user requirements and operate in an integrated fashion with other systems.

In what follows, several modern tools are described.

3.4.3.3.2.1 CCC

CCC (Change and Configuration Control environment) is an integrated set of tools that keeps track of changes and all configurations of anything that can be represented in machine readable form. As such, CCC is applicable to system hardware and software documentation as well as to software per se.

CCC has found applications to controlling system specification configurations. It is currently being employed by the U.S.'s Federal Aviation Administration to control major equipment specifications as illustrated in Figure 3-11.

CCC can also be used directly for controlling software configuration. Here, CCC automatically maintains all versions of software that have been created as well as a record of all changes that were ever made. Thus CCC can reconstruct on demand any program or document as it was on a specific date and time. For example, a user could request a copy of a program as it was on Thursday, November 10, 1984 or a list of all the changes that were introduced in connection with a software trouble report, or a list of all the changes introduced into a selected software routine. (See Figure 3-12 for example).

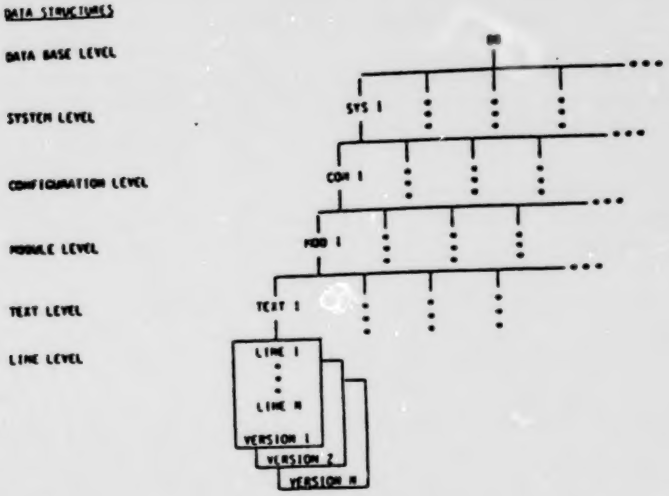
CCC costs $1,500.00 (U.S.) per year to lease and $30,000.00 (U.S.) to acquire. Further information on the capabilities of CCC is contained in Appendix A.

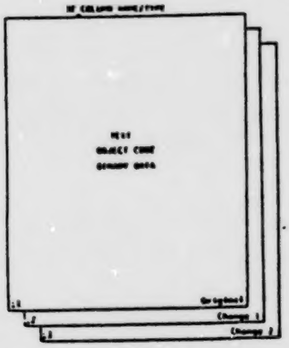
3.4.3.3.2.2 CAE MAINTENANCE MANAGEMENT SYSTEM

Developed by CAE Ltd. of Montreal to support maintenance management of a power generation facility. This system could be simultaneously applied to configuration management. The system offers on-line report specification and information retrieval for either maintenance or configuration management purposes. Still in the final development stages, information on the system is limited. However, a demonstration provided by CAE offered convincing evidence of the systems ability to:

- o operate graphic system descriptions;
- o allow easy input of data to the databasd;
- o allow easy report specification; and
- o provide reports based on equipment identification outlining for the equipment specified, relevant technical documentation, maintenance history, outstanding Engineering Orders, etc.

CCC AS A CONFIGURATION MANAGEMENT TOOL FOR TEXT

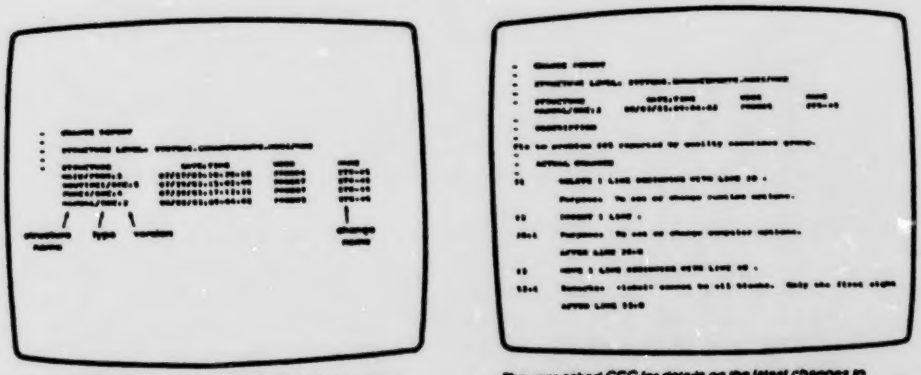

DATA STRUCTURES
DATA BASE LEVEL
SYSTEM LEVEL
CONFIGURATION LEVEL
MODULE LEVEL
TEXT LEVEL
LINE LEVEL
DB
SYS 1
CON 1
MOD 1
TEXT 1
LINE 1
LINE N
VERSION 1
VERSION 2
VERSION N


TEXT
OBJECT CODE
BINARY DATA
Original
Change 1
Change 2

- ACCESS CONTROL SPECIFICATION:
  READ, WRITE, MANAGER BY USER AND/OR CLASS
- TRAIT SPECIFICATION:
  SCOPE, ARCHIVE, COMPRESSION, ENCRYPTION
- VERSION NUMBER
- DATE-TIME TAG
- USER ID TAG
- CHANGE NAME TAG
- CHANGE DESCRIPTION TAG
- VARIABLE RECORD LENGTH
- UNLIMITED NUMBER OF LINES

FIGURE 3–11

CCC AS A SOFTWARE CONFIGURATION MANAGEMENT TOOL


structure name
type
version
change name

The user asked CCC for a list of all the structures that were changed to solve Software Trouble Report #45 (STR-45). The report specifies the name, type, and version of each structure, when they were changed, and who made the change.

The user asked CCC for details on the latest changes to MANUAL/DOC. The description of the changes, as well as the actual lines that were changed, are documented.

FIGURE 3–12

3.4.3.3.2.3 ADTEC: ENGINEERING CHANGE PROPOSAL MANAGEMENT INFORMATION SYSTEM

This system provides a description of cost data and status of configuration changes, sequenced by system and/or equipment. The system comprises three reports:

- o system equipment summary;
- o estimated cost report; and
- o summary report.

This summary system is distinct inasmuch as it focuses clearly on the cost implications of configuration changes. Further details of the system outputs are contained in the pages that follow.

3.4.3.3.2.4 BILL OF MATERIALS PROCESSORS

For hardware systems, a wide range of bill of materials processing packages offer automated assistance for maintaining configuration status records. A typical package is available from IBM which offers the following:

- o Provides functions to create and maintain descriptive information about production and supply items, and to create and maintain product bills of material changes;
- o Provides on-line processing for:
  - Creation and maintenance of item, bill of material, engineering change data and related bill of material changes;
  - "Same-as-except" bill of material creation;
  - Deletion and/or replacement of a component in all its usages based on the effective date of an engineering change;
  - Validity checking of input data;
  - Continuity checking and low level code maintenance; and
  - Creation and maintenance of responsibility data used in sending action messages.
- o Product structuring capabilities include:
  - Sequencing of bills of material other than by component item number;
  - Multiple occurrences of components in an assembly;
  - Support of phantom codes; and
  - Support of options and variants within a bill of material with a related usage probability percentage.
- o Provides full on-line inquiry capabilities including:
  - Individual item data;
  - Bill of material explosions;
  - Bill of material implosions;
  - All engineering changes for an item or detail information for a specific engineering change; and
  - A list of functions available to the terminal user.

3.4.3.3.3 RECOMMENDATIONS

1. A pilot project should be undertaken to establish equipment on a micro-based system. The pilot should utilize software tailored to Canadian Air Transportation Administration requirements and should dovetail with existing needs and procedures to support maintenance activities. The CAE system would be appropriate to this need and should be considered as a unique opportunity to encourage domestic involvement in this important area.

2. The CCC system should be leased or purchased and applied to the control of equipment specifications on a pilot basis.

3.4.3.4 LIFE CYCLE COSTING

3.4.3.4.1 REQUIREMENT

Life cycle costs constitute a cornerstone on which air navigation systems are designed, approved, installed, and operated. Life cycle costing is also a key consideration in evaluating design changes, for instance, to determine which system elements have the greatest impact on life cycle costs, and how their cost elements are affected by changes in design characteristics.

Life cycle cost also plays an important role in assessing logistics support considerations such as maintenance and repair strategies, spares support, and organizational alternatives.

Life cycle costs are typically related to a pre-determined cost breakdown structure (such as in the U.S. Federal Aviation Administration Order 1810.3). Figure 3-13 shows a typical life cycle cost breakdown structure based on standard life cycle phase definitions as applied to configuration management, and a typical cost structure based on these life cycle phases derived from general literature on this subject. Within each cost heading, more detailed breakdowns occur. These further breakdowns need to reflect the particular nature of the equipment under consideration. A sample breakdown used by ARINC Research Corporation in developing life cycle cost estimation procedures for the Federal Aviation Administration is outlined in Table 3-2.

The Canadian Air Transportation Administration requires a tool to assist in estimating life cycle costs in accordance with a cost structure comparable to that outlined in Appendix A.

LIFE CYCLE COST COST CATEGORIES

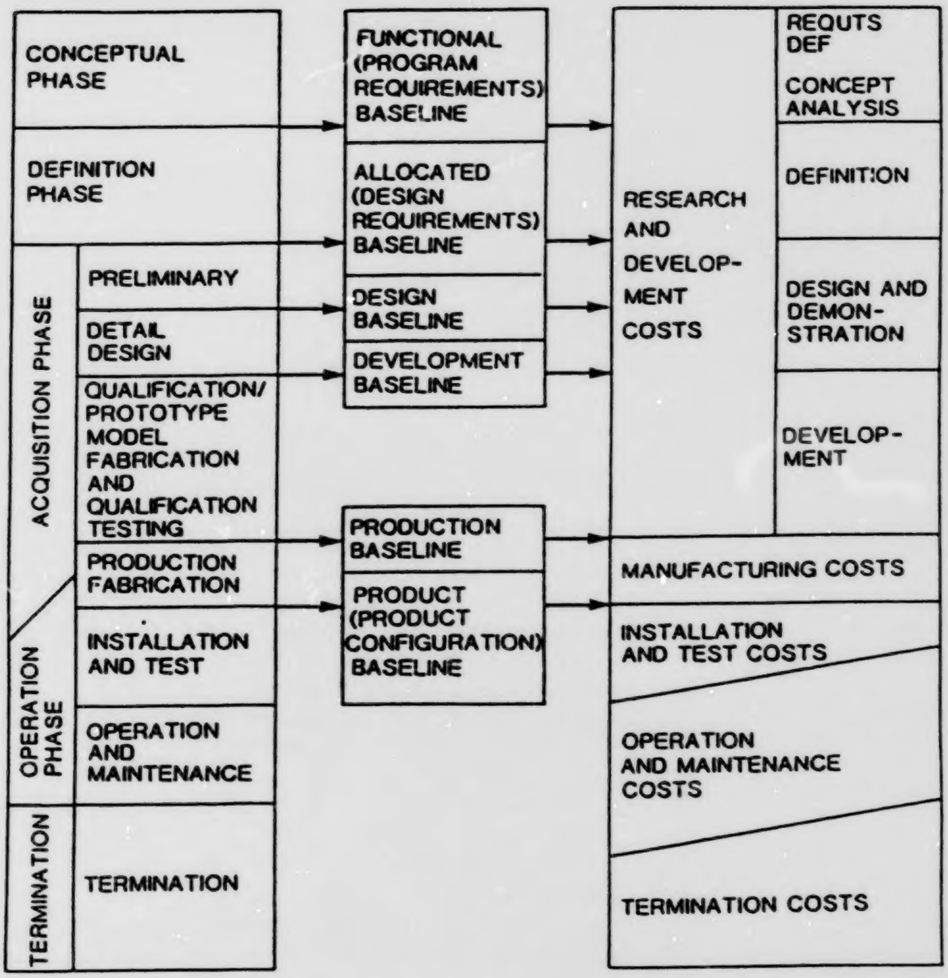

CONCEPTUAL PHASE
DEFINITION PHASE
ACQUISITION PHASE
PRELIMINARY
DETAIL DESIGN
QUALIFICATION/ PROTOTYPE MODEL FABRICATION AND QUALIFICATION TESTING
PRODUCTION FABRICATION
OPERATION PHASE
INSTALLATION AND TEST
OPERATION AND MAINTENANCE
TERMINATION
TERMINATION
FUNCTIONAL (PROGRAM REQUIREMENTS) BASELINE
ALLOCATED (DESIGN REQUIREMENTS) BASELINE
DESIGN BASELINE
DEVELOPMENT BASELINE
PRODUCTION BASELINE
PRODUCT (PRODUCT CONFIGURATION) BASELINE
RESEARCH AND DEVELOP- MENT COSTS
REQUTS DEF
CONCEPT ANALYSIS
DEFINITION
DESIGN AND DEMON- STRATION
DEVELOP- MENT
MANUFACTURING COSTS
INSTALLATION AND TEST COSTS
OPERATION AND MAINTENANCE COSTS
TERMINATION COSTS

FIGURE 3—13

COST BREAKDOWN STRUCTURE DEVELOPED BY ARINC RESEARCH LTD.

RESEARCH AND DEVELOPMENT COSTS
- Requirements Definition
- Concept Analysis
- Design and Demonstration
- Full Scale Development

TOTAL RESEARCH AND DEVELOPMENT COSTS

ACQUISITION COST

INSTALLATION COST

NONRECURRING LOGISTIC SUPPORT COSTS
- Initial Spares
- Transportation
- Inventory Entry
- Support Equipment
- Documentation
- New Facilities

TOTAL NONRECURRING LOGISTIC SUPPORT COSTS

RECURRING LOGISTIC SUPPORT COSTS
- Replenishment Spares
- On-Site Maintenance
- Off-Site Maintenance
- Inventory Management
- Support Equipment O&M
- Replacement Training
- Documentation Revision
- Repair Facilities Operations
- Site Operation

TOTAL RECURRING LOGISTIC SUPPORT COSTS

TERMINATION COSTS
- Dismantling
- Transportation and Packaging
- Site Restoration

TOTAL TERMINATION COSTS

SALVAGE VALUE

TOTAL LIFE-CYCLE COST

TABLE 3-2

3.4.3.4.2 RECOMMENDATION

The RCA PRICE H and PICE S systems appear well suited to meeting the Canadian Air Transportation Administration's requirements for estimating the development and production costs for hardware and software. PRICE H is being used by the system integrator to estimate hardware costs for the U.S. National Airspace System Plan and is currently under consideration by defense authorities in Canada as a cost estimating tool. The PRICE H and PRICE S systems are available along with training and ongoing support. Other available software tools do not offer this compatibility or the training and ongoing support feature.

For operations and logistic support costing, no off-the-shelf support tool exists that can accommodate specific operating and maintenance policies envisaged by the Canadian Air Transportation Administration. The ARINC Corporation is currently developing a special purpose cost estimating tool, specifically adapted to Federal Aviation Administration practices. The Canadian Air Transportation Administration will need to embark on a similar development to meet its requirements. The cost and feasibility of this overview should be assessed in light of the success of the Federal Aviation Administration's initiative which is currently underway.

Figure 3-14 illustrates a proposed scheme for combining off-the-shelf and specially adapted cost estimating tools to equip the Canadian Air Transportation Administration with an independent life cycle cost estimating capability for radically new equipment.

PROPOSED LIFE CYCLE COST SUPPORT TOOLS

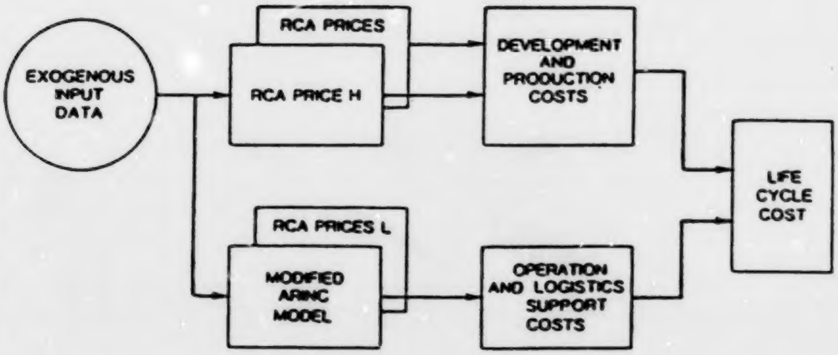


FIGURE 3—14

3.4.3.5 PROGRAM RISK MANAGEMENT

3.4.3.5.1 REQUIREMENT

There is a growing need within the Canadian Air Transportation Administration to ensure that actual project schedules, technical outcomes, benefits, and expenditures agree with plans and forecasts. With substantial increases envisaged in the capital spending plan, this requirement will become more critical and at the same time more difficult to ensure.

Figure 3-15 illustrates the situation faced by planners in seeking to make difficult choices and tradeoffs in the face of uncertainty. At the outset only rough estimates of cost, time, performance, and eventual benefits are available. At each stage in the program or project life cycle new information emerges that serves to reduce the uncertainty associated with the outcome. Along the way, however, major decisions are needed that commit financial, time, and technical resources. Inevitably, these decisions hinge on forecasts and assumptions that are in themselves uncertain.

UNCERTAINTY AND THE PROJECT LIFE CYCLE

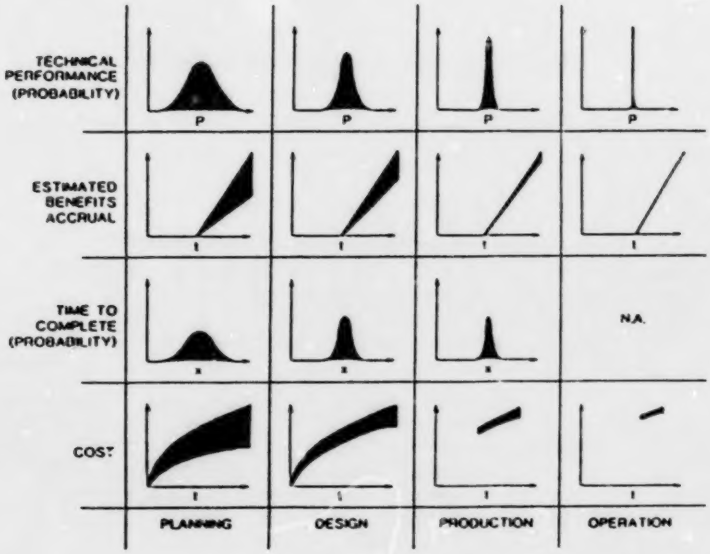

TECHNICAL PERFORMANCE (PROBABILITY)
P
P
P
P
ESTIMATED BENEFITS ACCRUAL
t
t
t
t
TIME TO COMPLETE (PROBABILITY)
x
x
x
N.A.
COST
t
t
t
t
PLANNING
DESIGN
PRODUCTION
OPERATION

FIGURE 3—15

3.4.3.5.2 COST-SCHEDULE RISK ANALYSIS TOOLS

Deterministic project schedules and cost estimates tend to be optimistic. The use of a model incorporating uncertainty, enables managers to qualify their estimates and may lead to adoption of overall estimates based not on averages but rather on probability concepts such as: "the cost will be $10 M or less with 80% probability."

Deterministic scheduling techniques identify one critical path, however, in an uncertain world things may go wrong. Delays may cause non-critical activities to become critical. Some packages estimate the susceptibility of non-critical activities to becoming critical as a percent factor (in X% of cases a given activity may become critical).

Packaged software programs allow project costs and activity times to be specified as statistical distributions. See Figure 3-16 for examples.

Using the model, these inputs result in estimates of output variables such as "total cost" and "estimated time to complete" not as single numbers, but as a spread of numbers with a probability asssigned to each. Outputs from these packages take the form shown in Figure 3-17.

Two off-the-shelf packages available to support cost-schedule risk analysis are:

PROMAP V: Log/An Inc.
924 Westwood Blvd.
Suite 730, Los Angeles, California
U.S.A.

PAN: Metier
808 4th Ave. S.W.
Suite 225, Calgary, Alberta
T2P 0K4

PROMAP V has been used previously by the Canadian Air Transportation Adminsitration in connectin with the Short Takeoff and Landing (STOL) and Joint Enroute and Terminal Surveillance (JETS) projects.

Both of these models incorporate time and cost uncertainty data. The PROMAP V model, in addition, takes into account uncertainties associated with resource and support systems availability. The influence of external economic and political factors, as well as technical risk factors, are taken into account by assessing these beforehand, (informally) developing risk avoidance or contingency plans, and incorporating them into the model. Figure 3-18 depicts the approach.

OUTPUT FROM A COST—SCHEDULE RISK MODEL

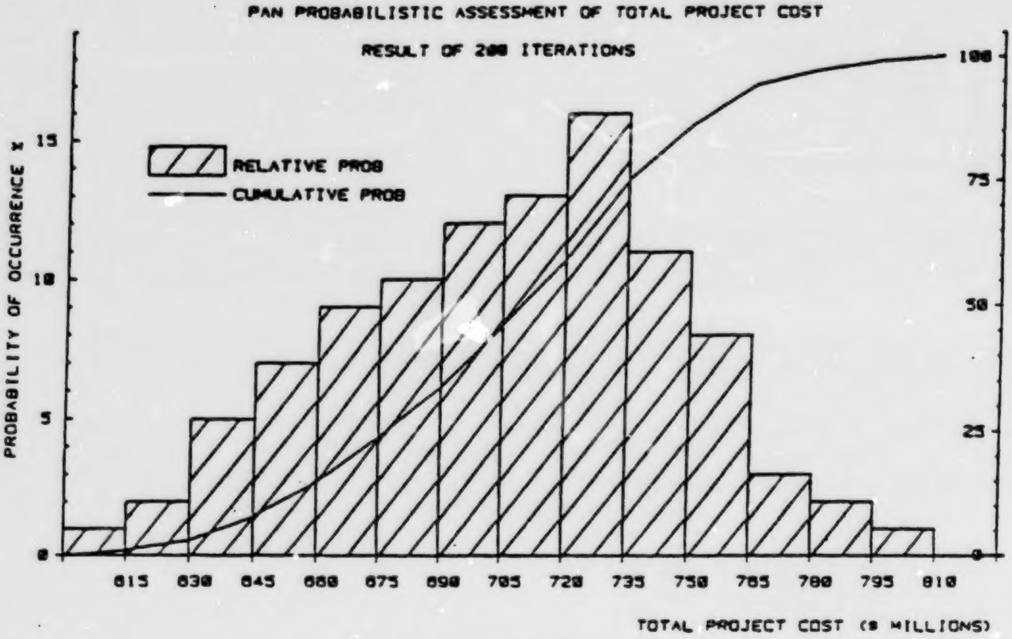
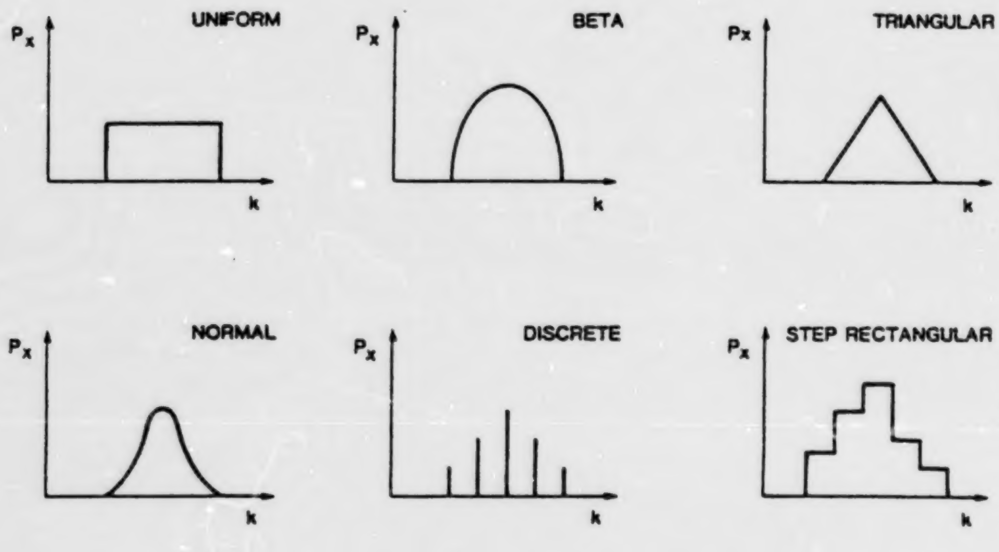


FIGURE 3—16

TYPICAL INPUT DISTRIBUTIONS


UNIFORM
BETA
TRIANGULAR
NORMAL
DISCRETE
STEP RECTANGULAR
P_x
k

$P_x(k) = d/d_k$ (probability $x \leq k$)

FIGURE 3—17

OVERVIEW OF A COST-SCHEDULE RISK MODEL

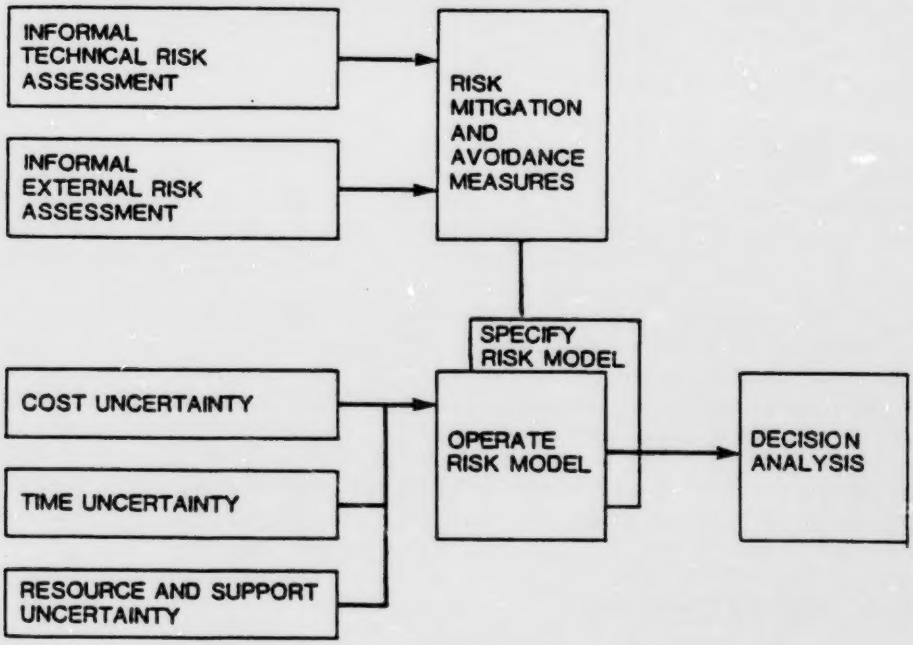

INFORMAL TECHNICAL RISK ASSESSMENT
INFORMAL EXTERNAL RISK ASSESSMENT
RISK MITIGATION AND AVOIDANCE MEASURES
SPECIFY RISK MODEL
COST UNCERTAINTY
TIME UNCERTAINTY
RESOURCE AND SUPPORT UNCERTAINTY
OPERATE RISK MODEL
DECISION ANALYSIS

FIGURE 3-18

3.4.3.6 BENEFIT AND BENEFIT-COST ASSURANCE

3.4.3.6.1 REQUIREMENT

Throughout the life cycle of an equipment, changes to requirements, design performance, costs, actual performance and/or auxillary benefits may necessitate a periodic review and updating of the original cost benefit assessment. The aim of such reviews, is to confirm to managers that the original cost/benefit basis on which the project was founded continues to be realistic or alternatively, to alert them to important changes as a basis for initiating corrective action.

Benefit assurance in this context refers to a periodic examination to ensure that actual benefits have materialized as planned.

Cost benefit assurance refers to a periodic check to ensure that the cost-benefit equation on which the project is predicated remains valid. The reporting requirements for Major Crown Projects include a semi-annual benefit cost review.

3.4.3.6.2 SUPPORT TOOLS

Each benefit-cost analysis is highly particular to the project involved. While some effort has been applied in the U.S. towards development of a general purpose cost-benefit model for air navigation systems, experience to date suggests that this model suffers from the usual disadvantages of large general purpose models. It is unwieldly.

Various general purpose benefit-cost packages are available that automatically combine time series of benefits and costs according to standardized instructions for discounting, identifying cost and benefit streams and indicators, as well as performing sensitivity analysis. Such tools require cost and benefit streams as data inputs, and simply perform the discounting and compilation of cost-benefit indicators on these streams. One such tool is CBPACK developed by the World Bank. (This package incorporates provision for conducting risk analysis and is proposed for that purpose in the preceding Section.)

3.4.3.6.3 RECOMMENDATION

Individual project managers would be responsible for:

- benefit assurance;
- periodic updating of the cost-benefit analysis on which their projects are based; and
- transmitting cost and benefit streams (each stream for a given cost or benefit type and user category) to the next echelon in the Program -- Major Project hierarchy.

The program manager would be responsible for:

- aggregating cost-benefit streams into a composite program summary;
- ensuring that major changes to assumptions and parameters such as forecasts or discount rates are brought to the attention of project managers and are reflected in periodic benefit-cost revisions; and
- identifying situations where changes in one project affect the calculation of benefits or costs in another and ensuring that the necessary revisions are incorporated.

The scheme would operate as shown in Figure 3-19. Here cost-benefit analyses are updated by individual project managers using data and disks provided by the Economic Analysis and Evaluation Air Division (DAPE) along with benefit assurance and cost control data as well as periodically revised planning parameters and assumptions provided by the Program Manager. The updated benefit-cost analyses are converted to revised benefit and cost streams. (Each stream pertaining to a specific benefit or cost category and stakeholder.) These cost and benefit streams, appropriately coded, are fed into CBPACK and are then processed to yield revised benefit-cost indicators and sensitivity analyses for the project and Major Project managers' use. The same data is transmitted to the Program Manager who prepares a revised program benefit-cost analysis.

BENEFIT AND COST-BENEFIT ASSURANCE

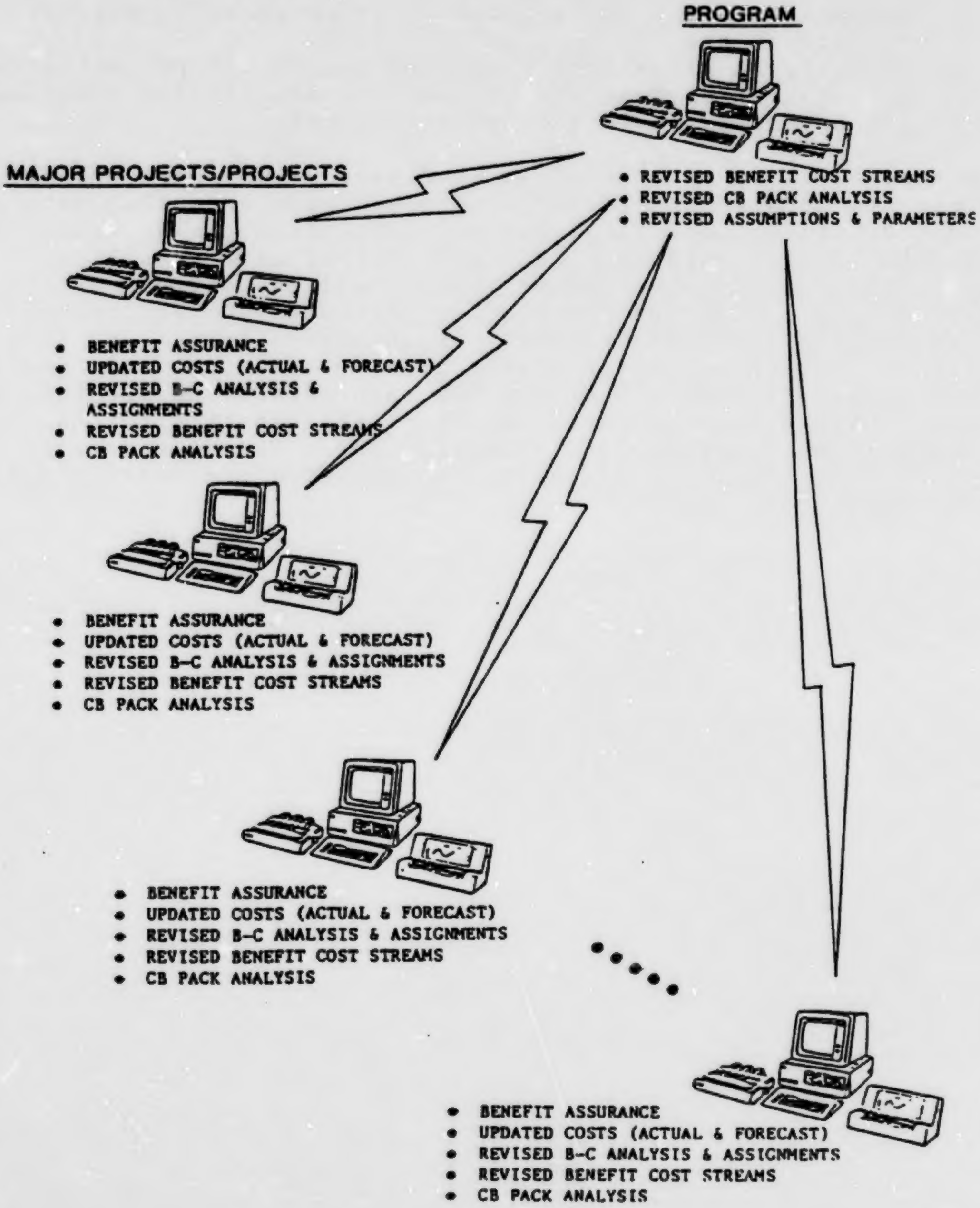

PROGRAM
• REVISED BENEFIT COST STREAMS
• REVISED CB PACK ANALYSIS
• REVISED ASSUMPTIONS & PARAMETERS
MAJOR PROJECTS/PROJECTS
• BENEFIT ASSURANCE
• UPDATED COSTS (ACTUAL & FORECAST)
• REVISED B-C ANALYSIS & ASSIGNMENTS
• REVISED BENEFIT COST STREAMS
• CB PACK ANALYSIS
• BENEFIT ASSURANCE
• UPDATED COSTS (ACTUAL & FORECAST)
• REVISED B-C ANALYSIS & ASSIGNMENTS
• REVISED BENEFIT COST STREAMS
• CB PACK ANALYSIS
• BENEFIT ASSURANCE
• UPDATED COSTS (ACTUAL & FORECAST)
• REVISED B-C ANALYSIS & ASSIGNMENTS
• REVISED BENEFIT COST STREAMS
• CB PACK ANALYSIS
• BENEFIT ASSURANCE
• UPDATED COSTS (ACTUAL & FORECAST)
• REVISED B-C ANALYSIS & ASSIGNMENTS
• REVISED BENEFIT COST STREAMS
• CB PACK ANALYSIS

FIGURE 3—19

CHAPTER 4

RESOURCE REQUIREMENTS (PERSON YEARS)

4.0 RESOURCE REQUIREMENTS (PERSON YEARS)

4.1 INTRODUCTION

We have so far described a group of Systems Engineering activities and processes, structured the Canadian Airspace Systems Plan into a series of Major Projects, described a Program Management Hierarchy, and identified the management support systems available to support implementation of the Canadian Airspace Systems Plan.

Adoption of those processes and activities, overlaid by a hierarchical structuring of the work and supported by the requisite management support systems will insure the most effective use of person years possible. It is against that backdrop that an estimate of resource requirements in terms of person years has been developed.

4.2 RESOURCE REQUIREMENTS (PERSON YEARS)

This section describes the estimated person year authorization and employment levels required to implement the Canadian Airspace Systems Plan while continuing to provide support of field maintenance and other ancillary activities with which the Facilities Engineering and Systems Development Branch is charged; the time periods in which those employment levels can realistically be expected to materialize; and suggests a strategy for accommodating the requirement.

While this paper focuses primarily on the System Engineering and Integration activities required to implement the Canadian Airspace Systems Plan, it must be recognized that there will be a workload impact on non-engineering activities also. Probably the greatest impact will be on the Air Navigation System Requirements Branch and the Air Traffic Services Branch. Initially they will be involved in identifying and documenting their Operational Service and Performance Requirements. The involvement does not end there. Air Traffic personnel must work closely with the engineering personnel as they proceed through the various levels of System Designs to insure that the Operational Performance Requirements are correctly understood. Air Traffic Services Branch involvement will diminish somewhat during the acquisition phase of the activity, however, system integration and checkout and field operational testing will again require a heavy Air Traffic Services involvement. The point is, there must be a recognition that implementation of the Canadian Airspace Systems Plan will involve continuing expenditures of person years by Offices of Collateral Interest (particularly the Air Traffic Services Branch and the Air Navigation System Requirements Branch) and the resources required to accommodate those person years must be provided. Although no attempt has been made to quantify the number of person years involved, the impact on Offices of Collateral Interest is clearly acknowledged and must be accommodated.

The following Table 4-1 represents the estimated number of engineering/technical person years required in each major project and supporting technical activity to implement the Canadian Airspace Systems Plan.

From the table it can be seen that in the early years the greatest need for engineering/technical staffing is related to System Engineering and Program Management and Control. This is followed by a decrease in staffing associated with those activities which, however, is approximately offset by increases in staffing in support of Major Projects.

ESTIMATED TECHNICAL PERSON YEARS (INCLUDING CONTRACTOR SUPPORT)

YEAR	*1984	1985	1986	1987	1988	1989	1990	1991 1993	1994 1996	1997 1999
o SYSTEM ENGINEERING	3	20	30	65	45	35	25	25	25	25
o PROGRAM MANAGEMENT AND CONTROL	0	35	25	15	15	15	15	15	15	15
o RADAR MODERNIZATION PROJECT (RAMP)	36@	40	60	70	80	80	70	50	30	0
o MICROWAVE LANDING SYSTEM (MLS)	12@	15	30	35	35	35	45	45	30	10
o FLIGHT DATA PROCESSING MODERNIZATION	0	12	25	50	55	55	50	40	20	0
o FLIGHT SERVICE STATION MODERNIZATION	0	10	30	50	55	55	50	40	25	20
o CONTROL, PERFORMANCE, AND MONITORING SYSTEM	0	3	10	15	15	15	15	10	5	0
o COMMUNICATIONS CONTROL SYSTEM	0	5	15	25	30	30	30	15	5	0
o DEVELOPMENT	0	20	30	20	20	20	20	20	20	20
o NAVIGATION	47	20	20	20	20	20	20	30	35	35
o COMMUNICATIONS	49.5	15	15	15	15	15	15	20	20	20
o RADAR/AUTOMATION	48.5	15	15	15	15	15	15	25	35	40
o TELECOMMUNICATIONS	36	8	8	8	8	8	8	10	10	12
o POLICY/MAINTENANCE	59.5#	15	15	15	15	15	15	25	25	25
o ADMINISTRATION	12.1+	10	10	10	10	10	10	10	10	10
o QUALITY ASSURANCE	19	10	20	25	25	25	25	20	15	10
o LAB/DMC	42	42	42	42	42	42	42	42	42	42
SUB-TOTALS		205	400	495	500	490	475	442	367	284
ADMINISTRATIVE/SUPPORT		140	140	140	140	140	140	140	140	140
TOTALS	364.6	435	540	635	640	630	615	582	507	424

* Current Facility Engineering and System Development Branch allocations (includes Administrative/Support and Risk Person Years).

18 Person Years in Policy and 41.5 Person Years in Maintenance.

@ Includes 10 Risk Person Years.

+ Office of the Director, Facilities Engineering and Systems Development (DFS) Person Years (includes 3.1 Risk Person Years).

TABLE 4-1

The System Engineering activity is faced with two initial tasks. The first is Level I and II System Design and the second is updating the Canadian Airspace Systems Plan. Those tasks are followed by Level III and IV System Design which generates the need for even greater staff in the third year of the Program after which the staffing requirement abates somewhat.

The Program Management and Control activity workload reflected in the first year of the Program involves the selection, acquisition, installation, and testing of Program Management and Control tools (e.g. cost control, schedule management, benefit assurance, etc.) Following installation and testing of the tools the workload decreases sharply and levels out through the remainder of the Program.

Among the technical support activities, only the Quality Assurance and Radar and Automation groups show any significant staffing changes. Quality Assurance staffing increases are projected in the early years to accommodate the increased workload resulting from the acquisition of significantly greater quantities of hardware and software. Radar and Automation staffing increases in the out years are associated with the integration and testing of hardware and software being delivered during that time period.

Clearly the staffing levels estimated exceed current person year authorizations. There are several ways in which the requirement for additional person years of staff could be accommodated. The basic staffing levels could be increased; the basic staff could be supplemented by capital person years by authorization of Treasury Board; or the basic staff could be supplemented by a Systems Engineering and Integration Support type contractor. Each of these approaches has inherent advantages and disadvantages. The best solution to the staffing dilemma is deemed to be a combination of the three.

There should be an increase in the basic staff to the level identified in the recently completed Ministry of Transport sponsored A-Base review. That staff should in turn be supplemented by the authorization of additional capital person years in recognition of the nature of this Program (i.e. it has a beginning and an end). Those Government workforces should be supplemented by a Systems Engineering and Integration and Support type contractor. The contract will provide the flexibility to quickly bring to bear the various skills and disciplines required in various phases of Program accomplishment (especially valuable when such skills and disciplines are not required for the entire Program). Such a contract would also provide the vehicle by which peaks and valleys in the workload can be leveled with a minimum impact on the Government workforce.

The scenario depicted in Figure 4-1 shows what is considered to be a reasonably well balanced mix of basic staff, capital person years, and contractor support. It reflects projected onboard person years as a function of time. It presupposes authorization of additional basic staff and capital person years for FY-1985 and the decision to proceed with a Systems Engineering and Integration Support type contract in that same time frame.

The figure shows an increase in basic technical staff to the level indicated in the recently completed Ministry of Transport sponsored A-Base review. Staffing up to the indicated level is spread across a two year period in recognition of the time realities associated with locating and employing technically qualified new employees.

Beginning in year two the basic staff begins to be supplemented by capital person years and support contract person years. The capital person years increase quickly for two years then level out for several years befor being phased out as the end of the Program approaches. The rate of increase in the early years is deemed to be about as great as could be expected, again, considering the time it takes to locate and hire the types of highly qualified employees required for this Program. The same is generally true for the support contractor. It is recognized that support contractors probably have much greater access to qualified personnel because they can "short-cut" many of the procedures and restrictions associated with Government hiring practices. The problem, however, is that a support contract of the magnitude envisioned here must be awarded competitively and the competitive contracting process is lengthy and time consuming. Assuming that the contracting process were to start immediately, it seems reasonable to expect the first contractor support personnel on the scene in no less than a full year.

Considering the foregoing realities, it becomes clear that during the early years of the Program, there is a person year shortfall, depicted in the figure as "The Problem". The first challenge of this Program, then, is to determine how to mitigate the shortfall.

There are two ways in which this problem can be addressed; through the seconding of Regional personnel to Headquarters; and through the acquisition of some short-term (1-2 years) contract support. It is unlikely that either alternative taken individually could accommodate the problem, therefore it seems that a combination of the two approaches is in order. Seconding Regional personnel to Headquarters has the inherent advantage of making up at least some of the person year shortfall. Of even greater significance, however, is the fact that it will begin to provide the basis for developing Regional understanding, acceptance, and support for the Program by giving the Regions a stake in it. In order for the contractual support to be effective, the vehicle for obtaining the support must be of a nature which can be consumated quickly and the contractor hired must be well versed in Systems Engineering and in Canadian Air Transportation Administration operations to help minimize the time spent in startup and the time normally wasted at the beginning of the learning curve.

RESOURCE REQUIREMENTS

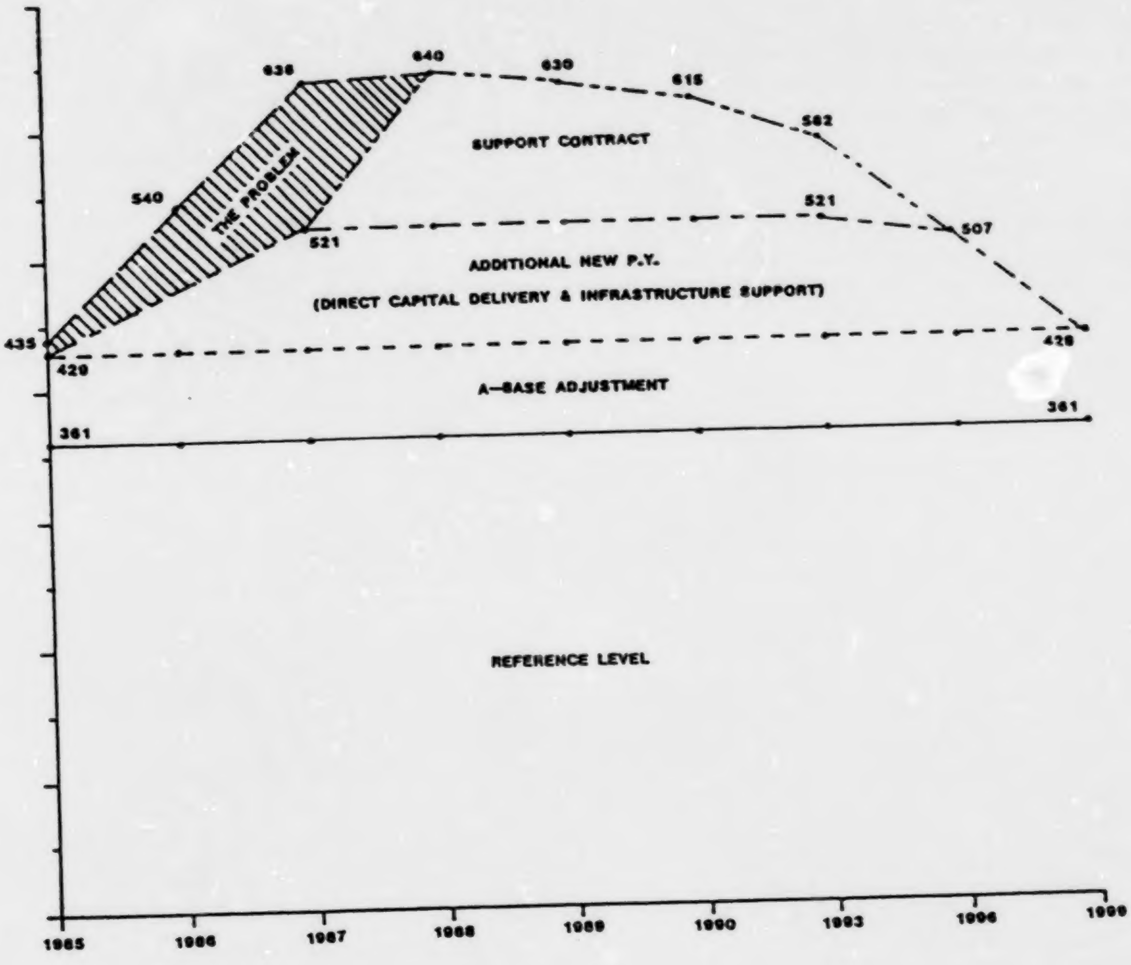


FIGURE 4—1

The acquisition of short-term contractual support, pending execution of a competitive contract for a Systems Engineering and Implementation Support type contract, will further mitigate the person year shortfall. The short-term contract support should extend to helping both technical and non-technical Canadian Air Transportation Administration personnel better understand the concepts and processes involved in developing and articulating the various levels of Operational Service Requirements, Operational Performance Requirements, and System Designs. It should also extend to assisting the Canadian Air Transportation Administration in the actual Level I and II System Design. Further, the contract should provide for assisting the Canadian Air Transportation Administration in selection of acquisition, installation, and testing of a set of Management Support and Program Control tools.

By approaching the person year shortfall in the foregoing manner, the Canadian Air Transportation Administration should be able to keep the Program moving at an acceptable pace until the appropriate levels of staffing can be brought onboard and a Systems Engineering and Integration Support type contractor can be retained and begin providing support.

CHAPTER 5

SUMMARY OF REQUIRED ACTIONS

5.0 SUMMARY OF REQUIRED ACTIONS

5.1 INTRODUCTION

In this section we will describe the totality of actions which must be initiated not only to assure that the Canadian Airspace Systems Plan is responsive to all appropriate requirements, but to assure that it will be implemented in a reasonable time frame at the lowest possible cost.

The Canadian Airspace Systems Plan is almost overwhelming in its magnitude. It is easily the most far-reaching and complex activity ever embraced by the Canadian Air Transportation Administration. A formidable amount of work has already been done in the Canadian Air Transportation Administration and much is in place. Nevertheless, the remaining work is still almost overwhelming in itself. Yet it is a job which must be done. And it must be done in a manner which builds upon what has already been completed.

Prudence dictates that the program be completed in a reasonable length of time and at the least possible cost. This mandates that the entire plan be implemented as a unit.

Operation of the existing system, and the resultant high level of safety, cannot be compromised during implementation of new or replacement systems. The system must continue to operate even as it is being changed.

Any implementation plans and strategy must build on the strengths of the existing organization.

It is within that framework that the action items described in the following section have been identified. These action items do not represent a shopping list from which one can pick and choose. Rather, they represent a totality of actions required to insure that the Canadian Airspace Systems Plan is responsive to all legitimate requirements and can be implemented.

Any delay in taking all of these actions will only serve to further complicate this alread complex activity, increase the risk that it can be accomplished, and result in the otherwise unnecessary expenditure of resources in the forms of dollars and people.

5.2 UPDATE THE CANADIAN AIRSPACE SYSTEMS PLAN

The Canadian Airspace Systems Plan must be reissued periodically, but it must be kept current between reprintings. The process described later in this paper for upgrading this planning document to a programming document will assure an appropriate level of discipline for the introduction of changes to the Canadian Airspace Systems Plan and must become the vehicle by which changes are introduced. This applies both to changes which add projects to the Plan and those which delete projects from it.

5.2.1 REQUIREMENTS IDENTIFIED IN THE CANADIAN AIRSPACE REVIEW AND ELSEWHERE WITHIN AND OUTSIDE THE CANADIAN AIR TRANSPORTATION ADMINISTRATION MUST BE INTEGRATED INTO THE PLAN

The Canadian Airspace Review activity will identify problems, both procedural and operational, which need to be addressed. Likewise, other sources from both within and outside the Canadian Air Transportation Administration will also identify problems needing attention. The process of addressing these problems must begin with an analysis of current services, system capabilities, equipment and programs along with projections of required services, future technologies, and forecasts of traffic demand and mix. Options must be analyzed and plans created to incorporate capabilities within the framework of the separate Major Projects envisioned in the Plan. Options will include both capital and non-capital alternatives. In some cases, the problem will be accommodated with a change of regulations or procedures. In other cases, the problem will be best addressed by an investment in equipment or facilities. It is those capital solutions which must be integrated into the Plan.

5.2.2 MANDATE BROAD-BASED ORGANIZATIONAL PARTICIPATION IN UPDATING THE CANADIAN AIRSPACE SYSTEMS PLAN

The Canadian Airspace Systems Plan has been embraced by top level Canadian Air Transportation Administration management. Therefore, a much broader organizational participation in its update is appropriate. As a minimum the Air Traffic Services Branch, the Air Navigation Requirements Branch and Regional counterparts of these Branches as well as those of the Facilities Engineering and Systems Development Branch must participate in developing these updates. Such participation will help insure that the results of the Canadian Airspace Review, levels of Operational Service Requirements determinations, and formally defined Operational Performance Requirements are factored into the Plan. This will result in two major benefits: First, it will help insure a thoroughly comprehensive document and, second, it will result in a much more widespread understanding and acceptance of the Canadian Airspace Systems Plan.

5.2.3 COLLAPSE THE TIME REQUIRED TO IDENTIFY REQUIREMENTS

The definition of Operational Service Requirements and Operational Performance Requirement, as well as the System Designs must be folded together so that they can proceed in parallel. Otherwise there can be no expectation that the Program will be accomplished in any reasonable time frame.

A number of seminars to help those involved understand the process by which this can be accomplished may be in order.

5.3 ORGANIZE MAJOR PROJECTS

Like and interdependent projects must be grouped into Major Projects and responsibility for their accomplishment assigned. This will require assigning a Project Manager and a small staff charged with developing the overall acquisition strategy and preparing the Project Approval Document for each Major Project.

5.3.1 INTRODUCE A HIERARCHICAL PROGRAM MANAGEMENT STRUCTURE

The introduction of a hierarchical Program Management Structure will permit clear assignment of responsibility for each facet of a Major Project and facilitate control of the entire Program.

It is clear that someone must be charged with the responsibility for implementing the Canadian Airspace Systems Plan. It is equally clear that in a business as usual mode of operation no one could stay on top of all the activities underway at any given point in time. Therefore, like and interdependent projects must be grouped together into what we have called Major Projects and responsibility for accomplishment assigned in a hierarchical fashion.

The Hierarchical Program Management Structure is one in which each individual contract is managed independently of all other contracts, each project is managed independently of all other projects, and each Major Project is managed independently of all other Major Projects so long as a set of predefined set of conditions and boundary values applicable to each are not affected.

It is these carefully predefined conditions (i.e. schedule, cost, etc.) and boundary values (i.e. inputs and outputs) which set this approach apart from the traditional hierarchical assignment of work. The Hierarchical Program Management Structure must be implemented.

5.3.2 SELECT AND INSTALL THE SUPPORT SYSTEMS REQUIRED FOR MANAGEMENT AND CONTROL OF THE PROGRAM

Decisions must be made early on as to the tools which will be utilized in support of Program Management and Control. These tools must be acquired and installed very early on in the Program to insure a coherent hierarchical management and control scheme. The risk of not doing this rapidly is that each project engineer or manager will devise their own scheme and it will become extremely difficult, if not impossible, to accumulate data from individual activities and progressively summarize it for the various levels of Canadian Air Transportation Administration and Treasury Board review.

5.3.3 UPGRADE THE STATUS OF THE CANADIAN AIRSPACE SYSTEMS PLAN FROM THAT OF A PLANNING DOCUMENT TO THAT OF A PROGRAMMING DOCUMENT

This action involves no more than a policy decision that a project will not be considered for inclusion in the budget unless it is contained in the Canadian Airspace Systems Plan. Preparation of a Project Approval Document for each Major Project as mandated in section 3.2.2 is not necessarily precedent to the establishment of this policy.

However, approval of those Project Approval Documents would certainly add legitimacy to the policy decision. Upon approval of the Project Approval Documents by the appropriate Project Review Committees, and the Treasury Board where appropriate, the Plan should then become a programming document. As an approved programming document the Plan could then serve as the control vehicle for development of the Multi-Year Operations Plan and Main Estimates. Likewise, projects should not be included in the Current Year Priority List unless they are addressed in the Canadian Airspace Systems Plan. At the same time there would remain in place an institutionalized process (i.e. the Project Approval Document approval process) for making changes to the Program. This sort of control is deemed imperative if the Program is to be acomplished at the least possible cost and with the least possible number of person years. The approved program must be the primary focus of each of the organizations involved with it.

5.4 ESTABLISH AN EXPANDED SYSTEM ENGINEERING ORGANIZATION WITHIN THE OFFICE OF THE OVERALL PROGRAM MANAGER

In both the planning and engineering phases of activity a great deal of attention must be given to Systems Engineering. The allocation of Operational Performance Requirements between facilities and between equipment within facilities must be done with great care. Interfaces must be clearly identified and inputs and outputs clearly defined. Existing capabilities must be assessed and determinations made as to what changes are required to satisfy the Operational Performance Requirements. This includes determining how the facilities should be linked together. Interim configurations designed to begin to yield benefits as soon as possible must be identified. Precedent and dependent activities and projects must be identified so that coherent schedules can be developed. Cost Control, Schedule Management, Configuration Management, Benefit Assurance, and Project Performance Analysis all come together in Systems Engineering. It is here where tradeoffs between Major Projects are made to assure that the total Program remains in balance, on schedule, and produces the desired benefits. System level test scenarios need to be developed. Projects need to be considered and treated as a group rather than as a series of individual projects. This applies not only to System Designs but also to Systems Integration, Deployment, and Operational Testing and Validation. Properly done this System Engineering effort will involve a considerable amount of interaction with, and participation by, the Air Traffic Services Branch.

Failure to establish a strong System Engineering capability promptly will virtually guarantee failure of the Program.

5.5 BEGIN LEVEL I DESIGN

Many basic requirements decisions have long since been taken and are well institutionalized in the Canadian Air Transportation Administration. Some requirements have been empirically developed and yet others have been inferred, both based on the extensive experience existing among those who have been responsive to Canadian Air Transportation Administration requirements over the years. System Design must begin immediately. A delay in beginning the design will only serve to further complicate an already complicated activity and increase the Program's cost by constraining design alternatives and creating the need for otherwise unnecessary interim interfaces -- which are always expensive.

5.6 INITIATE IMMEDIATE ACTION TO OBTAIN AUTHORIZATION OF THE PERSON YEARS REQUIRED TO PLAN AND IMPLEMENT THE CANADIAN AIRSPACE SYSTEMS PLAN

The number of technical/engineering and support person years required to plan and implement the Canadian Airspace Systems Plan while at the same time continuing to provide support of field maintenance and other ancillary activities with which the Facility Engineering and System Development Branch is charged are identified in Chapter 4 of this report. The breakdown between basic staff, capital person years, and contractor support person years is considered to provide a reasonable mix. However, it is the total requirement which is of overriding importance. Inability to obtain authorization for the base number of person years indicated simply means that the shortfall must be made up through increased use of contractor person years.

Although no effort has been made to quantify the requirement, the continuing impact of implementing the Canadian Airspace Systems Plan on Offices of Collateral Interest (particularly the Air Traffic Services Branch and the Air Navigation System Requirements Branch) must also be acknowledged and resources required to accommodate that impact must be provided.

5.7 SUMMATION

The Canadian Air Transportation Administration has wisely embarked on a System Engineering approach to modernizing and improving the electronic infrastructure of the Canadian Airspace System. There will be many temptations to veer from that course. Some of those temptations will come in the guise of fiscal restraint. Others will come from those who are unable to comprehend the full significance of a well thought through System Engineering approach. Any such temptations must be resisted with a single mindedness of purpose -- to upgrade and modernize the electronics infrastructure of the Canadian Airspace System in the most efficient manner possible.

The foregoing actions must be taken in totality and they must be taken now! Anything less than that will result in unnecessary waste of people and dollar resources.

APPENDIX A

PROGRAM SUPPORT TOOLS BACKGROUND TO PROCESSES & TOOL SELECTION

1.0 INTRODUCTION

This appendix outlines for each support tool the background process to which it lends support. In addition for some support tools, where a wide variety of offerings were considered, details are provided to indicate the basis on which a particular tool selection was made.

2.0 SCHEDULE COST AND RESOURCE ALLOCATION

2.1 SCHEDULE, COST AND RESOURCE ALLOCATION PROCESS

2.1.1 Schedule

Figure 1 illustrates the hierarchy of schedules for the program, major projects, projects and subprojects/contracts. The degreee of detail increases at lower levels in the hierarchy and schedules at each level are subnetworks of higher level activities.

At each level, the schedule is the basis for planning, resourcing, progress involvement and for making plan changes. Figure 2 depicts the flow of schedule progress and plan change information. Progress information flows upwards based on raw progress data fed in at the contractor/subproject level. This progress information serves to update each network in the hierarchy, and may in turn suggest the need for plan changes. Where a plan change is required, this is first examined to determine its likely impact on other program activities. Where the impact is confined to activities within the span of control of the manager initiating the change request, the plan change can be introduced on the authority of that manager. Where other activities are likely to be effected, the change request is presented at the next level and so on.

2.1.2 Cost

The flow of cost information follows closely the program/project structure shown in Figure 2. At each level, cost data is summarized for presentation at the next higher level. Also at each level, a review process analyses the implications of actual and forecast revisions in conjunction with schedule information. Significant changes in planned spending are submitted to higher levels for approval and directed changes flow downwards.

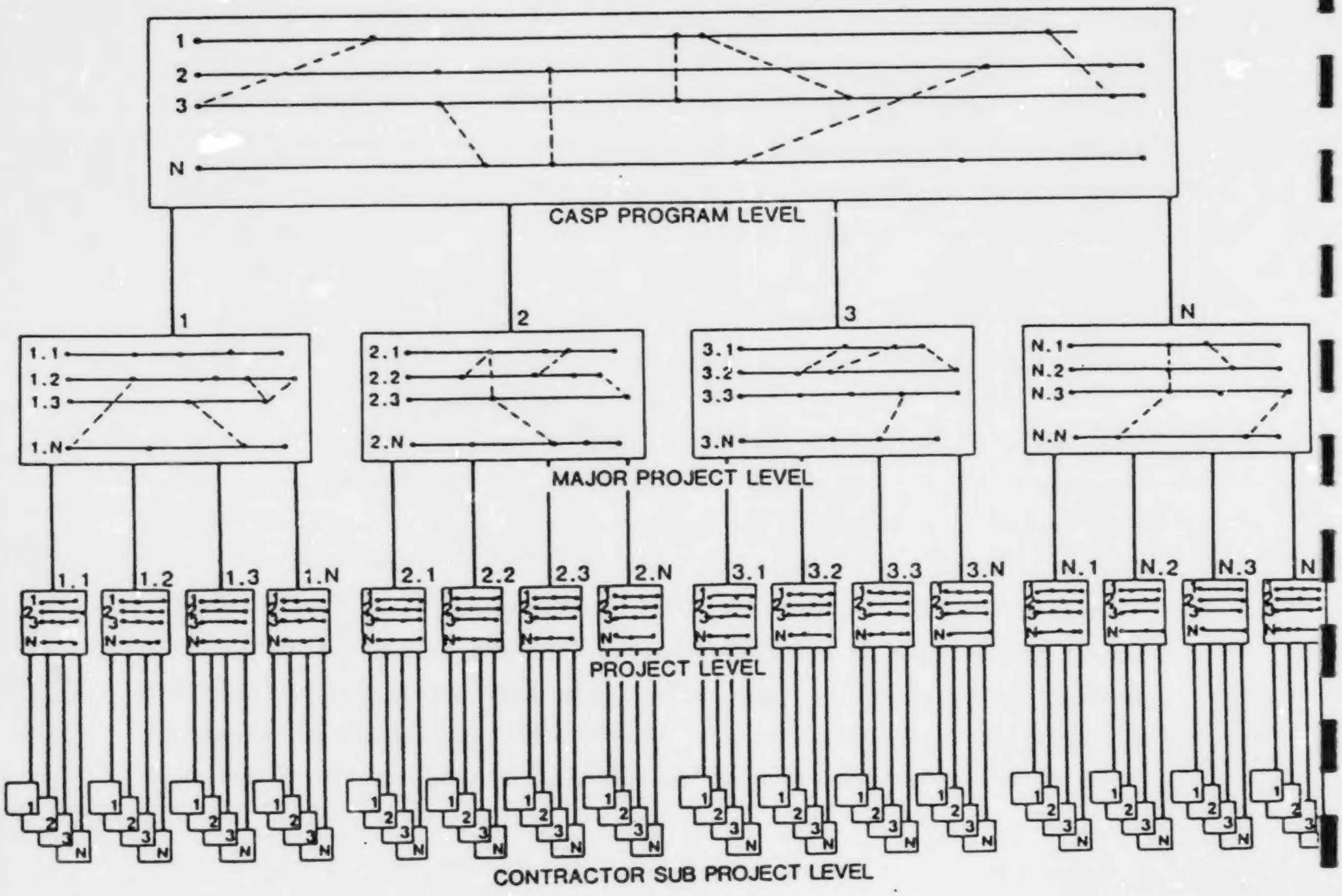

CASP PROGRAM LEVEL
MAJOR PROJECT LEVEL
PROJECT LEVEL
CONTRACTOR SUB PROJECT LEVEL
1
2
3
N
1.1
1.2
1.3
1.N
2.1
2.2
2.3
2.N
3.1
3.2
3.3
3.N
N.1
N.2
N.3
N.N

FIGURE 1: SCHEDULE STRUCTURE

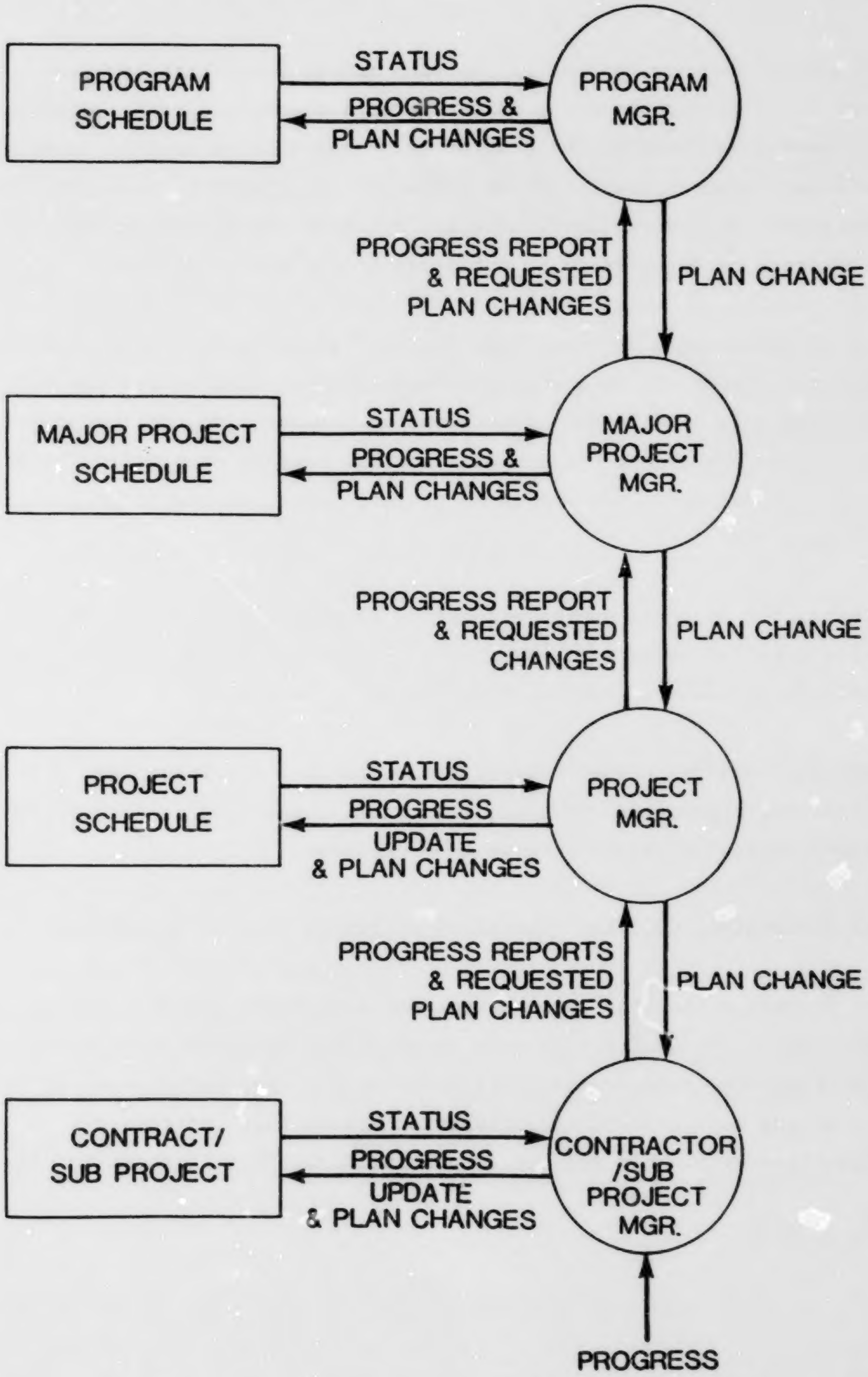

PROGRAM SCHEDULE
STATUS
PROGRESS & PLAN CHANGES
PROGRAM MGR.
PROGRESS REPORT & REQUESTED PLAN CHANGES
PLAN CHANGE
MAJOR PROJECT SCHEDULE
STATUS
PROGRESS & PLAN CHANGES
MAJOR PROJECT MGR.
PROGRESS REPORT & REQUESTED CHANGES
PLAN CHANGE
PROJECT SCHEDULE
STATUS
PROGRESS UPDATE & PLAN CHANGES
PROJECT MGR.
PROGRESS REPORTS & REQUESTED PLAN CHANGES
PLAN CHANGE
CONTRACT/ SUB PROJECT
STATUS
PROGRESS UPDATE & PLAN CHANGES
CONTRACTOR /SUB PROJECT MGR.
PROGRESS

FIGURE 2: FLOW OF PROGRESS AND PLAN CHANGE INFORMATION

2.1.3 Allocation

Allocation data is handled in the same manner as cost information. At each level in the hierarchy, allocations and schedule change decisions are optimized based on the cost of delays versus the need to promote balanced resource usage. Where resources are shared by several components at a given level or where schedule changes effect another component, resource usage is optimized at the next level up.

The allocation process operates in either of two modes. First, it can adjust the schedule so that prescribed resource limitations are not exceeded while at the same time ensuring minimum time for the project. Second, it can adjust the schedule so that certain prescribed milestone dates are met while attempting to minimize resource peaks. Figure 3 illustrates.

Application of the resource allocation component will result in a precise start date for every activity instead of an earliest start date for each activity as results from a critical path calculation.

Typically several resource types can be handled simultaneously by the optimizing algorithm. However, the system's performance degrades when large numbers of resources must be considered.

2.2 THE SCHEDULING, COST AND ALLOCATION SYSTEM AS PART OF THE PROCESS

The project scheduling cost control and allocation system (SCC) is embedded in the system hierarchy shown in Figure 2. At each level in the hierarchy, the manager responsible has at his disposal a computer based scheduling cost control and allocation system that controls all activities within his span of responsibility. This is shown in Figure 4.

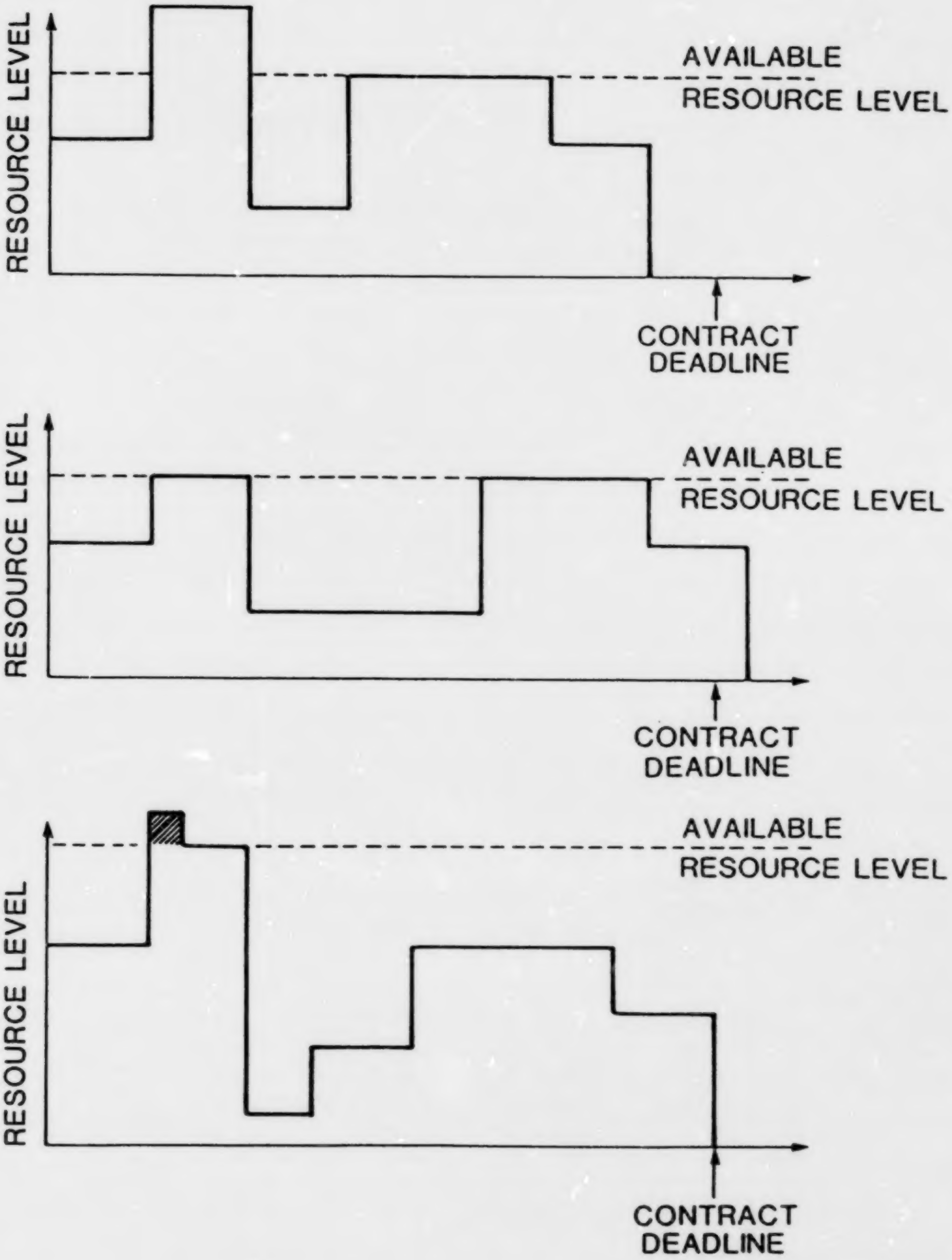


FIGURE 3: ALLOCATION

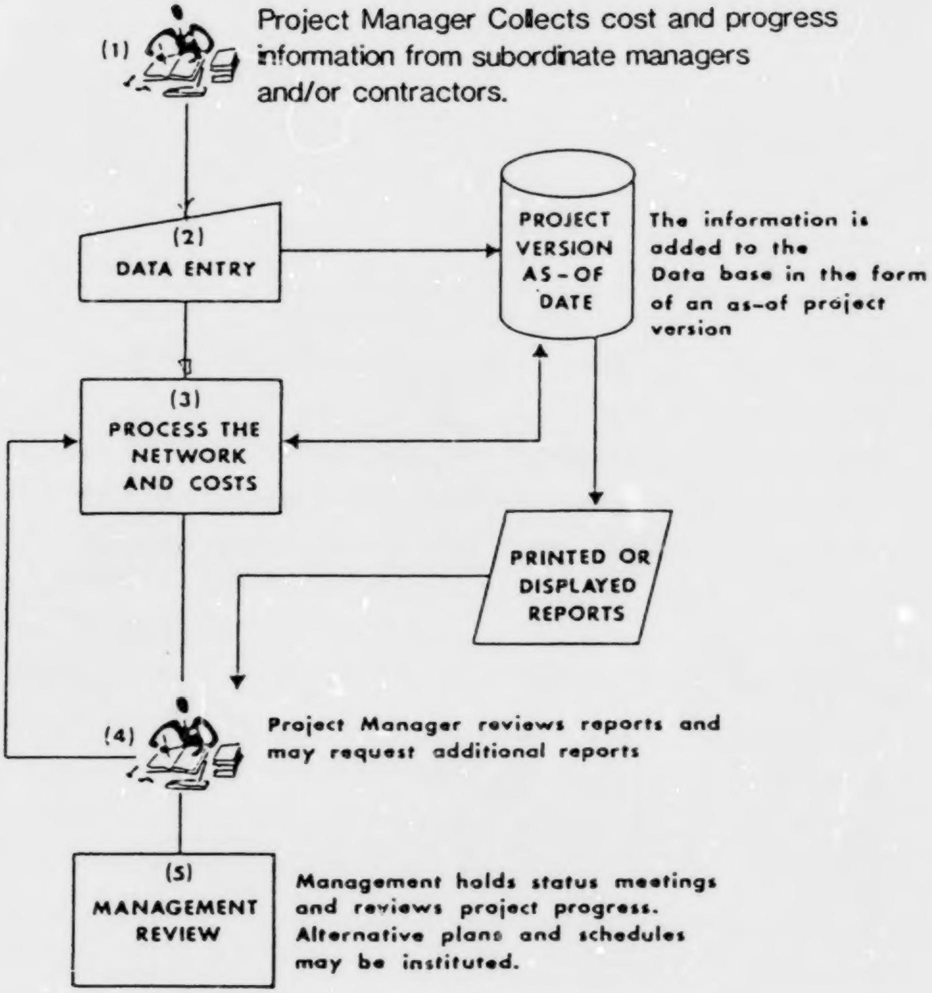

(1)
Project Manager Collects cost and progress information from subordinate managers and/or contractors.
(2)
DATA ENTRY
PROJECT VERSION AS-OF DATE
The information is added to the Data base in the form of an as-of project version
(3)
PROCESS THE NETWORK AND COSTS
PRINTED OR DISPLAYED REPORTS
(4)
Project Manager reviews reports and may request additional reports
(5)
MANAGEMENT REVIEW
Management holds status meetings and reviews project progress. Alternative plans and schedules may be instituted.

FIGURE 4: MANAGERS' INTERACTION WITH SCC SYSTEM

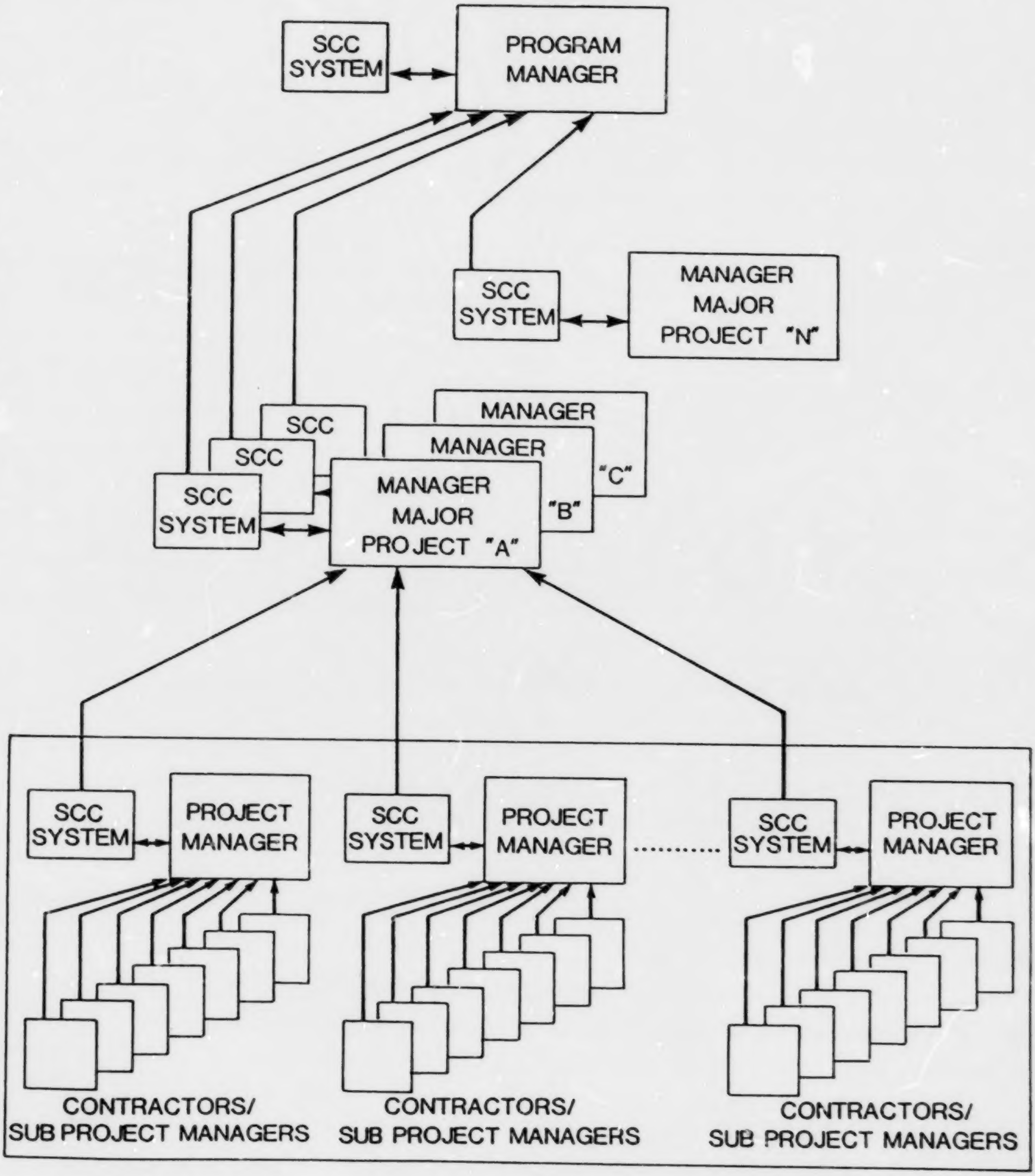

SCC SYSTEM
PROGRAM MANAGER
SCC SYSTEM
MANAGER MAJOR PROJECT "N"
SCC
MANAGER
SCC
MANAGER
"C"
SCC SYSTEM
MANAGER MAJOR PROJECT "A"
"B"
SCC SYSTEM
PROJECT MANAGER
SCC SYSTEM
PROJECT MANAGER
SCC SYSTEM
PROJECT MANAGER
CONTRACTORS/ SUB PROJECT MANAGERS
CONTRACTORS/ SUB PROJECT MANAGERS
CONTRACTORS/ SUB PROJECT MANAGERS

FIGURE 5: SCHEDULE AND COST CONTROL SYSTEM (SCC) SCHEMATIC

The manager interracts on a periodic basis with the SCC. This involves inputing raw data and processing the data to generate a variety of reports on past performance and revised projections. The manager then reviews this information to determine what management action is needed, possibly inputing new data to test the effects of alternative management decisions; consults with senior and subordinate managers on the best course of action and finally, dispatches summary information to the next higher level in the hierarchy. This is shown in Figure 5.

Analysis of summary information at the project, major project or program levels may result in management decisions that impact lower levels in the hierarchy. For example, a major project manager, in response to under spending on a given project, might decide to accelerate another project. This will result in discussion with the project managers concerned, regarding ways in which this can be accomplished. The resulting agreed upon changes are input to the SCC by the project managers. The major project manager sees the result when information exchange occurs between the project SCC and the major project SCC. The point here is that senior managers do not have direct access to subordinates' schedules and cost databases.

2.3 INPUT AND OUTPUT INFORMATION FOR THE SCHEDULE, COST AND ALLOCATION SYSTEM

Figure 6 depicts the flow of information into and out of the system. These inputs and outputs occur at each level in the hierarchy, with information at a given level being derived either from lower levels (viz. progress data), higher levels (viz. budget data) or from the final level (viz. budget reallocations).

Typical output reports are described below. These include examples of tabular as well as graphic output for schedule and cost control.

2.3.1 Cost Reports:

This information is depicted generally in Figure 7 and details of the reports required are as follows:

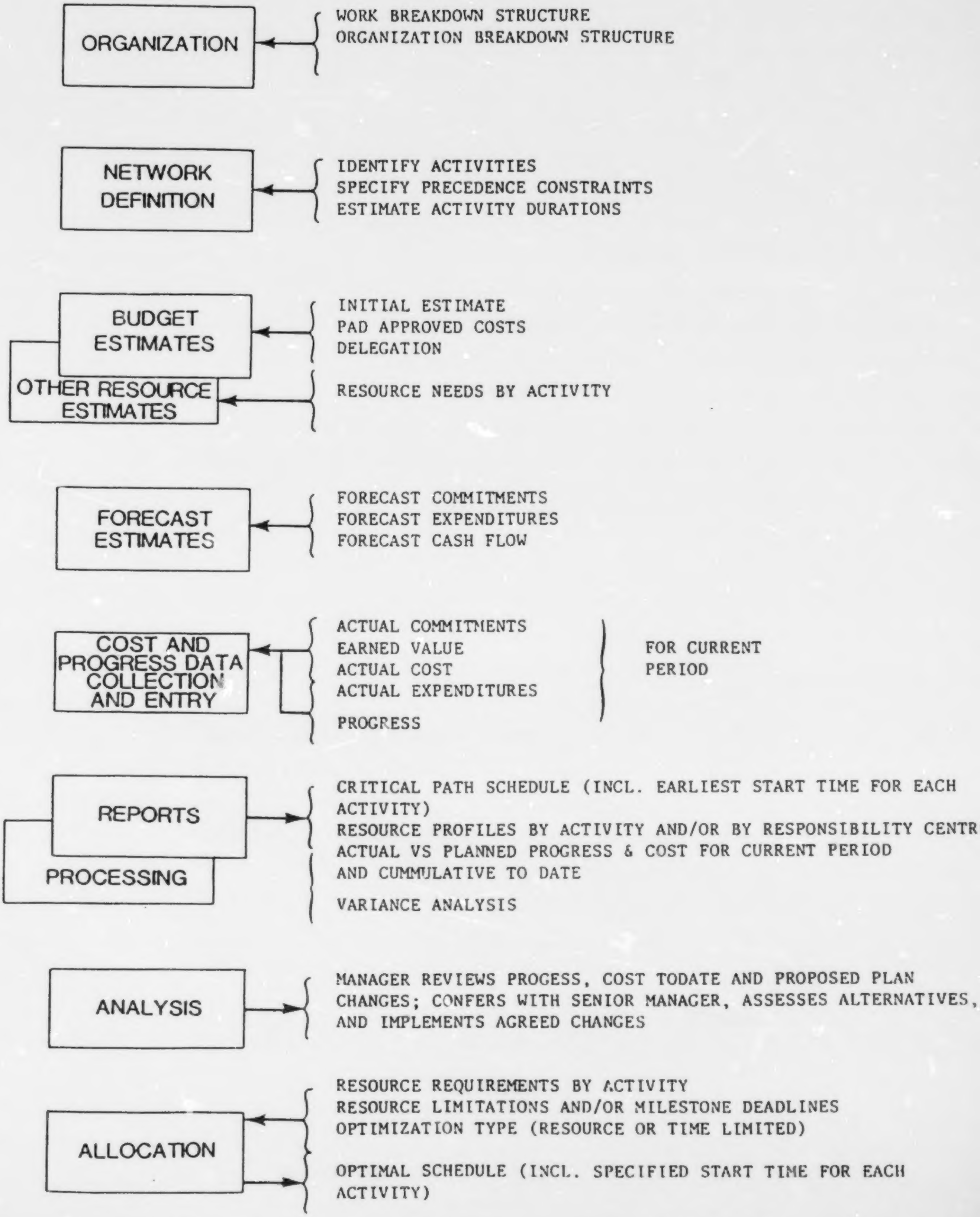
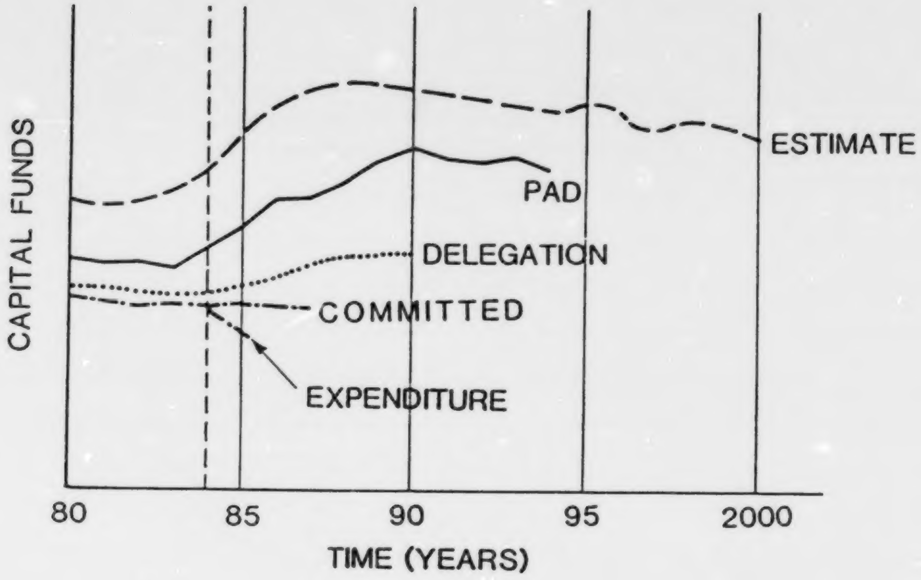

ORGANIZATION
WORK BREAKDOWN STRUCTURE
ORGANIZATION BREAKDOWN STRUCTURE
NETWORK DEFINITION
IDENTIFY ACTIVITIES
SPECIFY PRECEDENCE CONSTRAINTS
ESTIMATE ACTIVITY DURATIONS
BUDGET ESTIMATES
INITIAL ESTIMATE
PAD APPROVED COSTS
DELEGATION
OTHER RESOURCE ESTIMATES
RESOURCE NEEDS BY ACTIVITY
FORECAST ESTIMATES
FORECAST COMMITMENTS
FORECAST EXPENDITURES
FORECAST CASH FLOW
COST AND PROGRESS DATA COLLECTION AND ENTRY
ACTUAL COMMITMENTS
EARNED VALUE
ACTUAL COST
ACTUAL EXPENDITURES
FOR CURRENT PERIOD
PROGRESS
REPORTS
PROCESSING
CRITICAL PATH SCHEDULE (INCL. EARLIEST START TIME FOR EACH ACTIVITY)
RESOURCE PROFILES BY ACTIVITY AND/OR BY RESPONSIBILITY CENTR
ACTUAL VS PLANNED PROGRESS & COST FOR CURRENT PERIOD AND CUMMULATIVE TO DATE
VARIANCE ANALYSIS
ANALYSIS
MANAGER REVIEWS PROGESS, COST TODATE AND PROPOSED PLAN CHANGES; CONFERS WITH SENIOR MANAGER, ASSESSES ALTERNATIVES, AND IMPLEMENTS AGREED CHANGES
ALLOCATION
RESOURCE REQUIREMENTS BY ACTIVITY
RESOURCE LIMITATIONS AND/OR MILESTONE DEADLINES
OPTIMIZATION TYPE (RESOURCE OR TIME LIMITED)
OPTIMAL SCHEDULE (INCL. SPECIFIED START TIME FOR EACH ACTIVITY)

FIGURE 6: INPUT AND OUTPUT INFORMATION FOR THE SCC SYSTEM



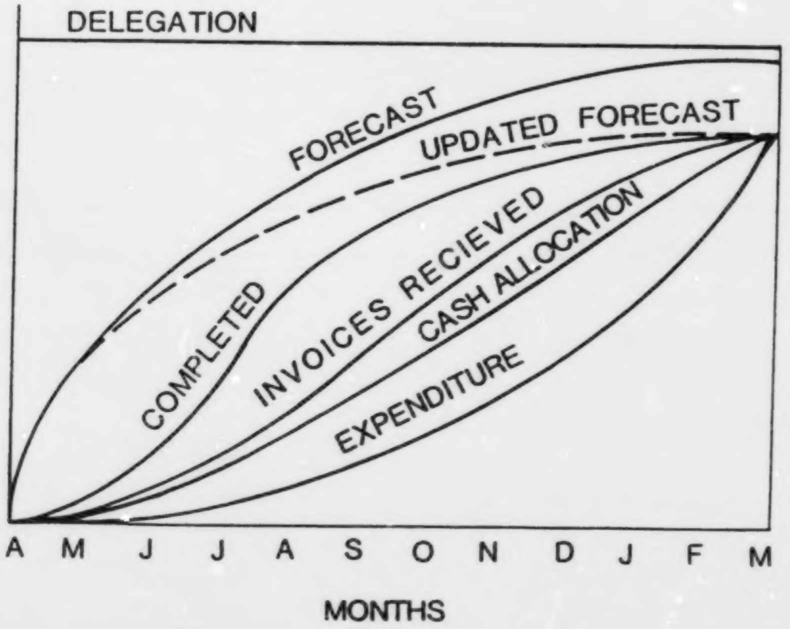


FIGURE 7: REQUIRED COST INFORMATION

A Schedule Reports

SPRG.1	Program Level:	Annual Program Schedule Summary
SPRG.2	Program Level:	Monthly Program Schedule Summary
MPR.1	Major Project Level:	Annual Major Project Summary
MPR.2	Major Project Level:	Monthly Major Project Summary
SPR.1	Project Level:	Annual Project Summary
SPR.2	Project Level:	Monthly Project Summary
CNT.1	Sub Project/ Contracter Level:	Annual Sub Project/Contractor Level Summary
CNT.2	Sub Project/ Contractor Level:	Monthly Sub Project/Contractor Level Summary

B Cost Reports

CPRG.1	Program Level:	Annual Program Cost Summary
CPRG.2	Program Level:	Cummulative Annual Program Cost Summary
CPRG.3	Program Level:	Monthly Program Cost Summary
CPRG.4	Program Level:	Cumulative Program Monthly Cost Summary
MPR.1	Major Project Level:	Annual Major Project Cost Summary
MPR.2	Major Project Level:	Cummulative Annual Major Project Cost Summary
MPR.3	Major Project Level:	Monthly Major Project Cost Summary
MPR.4	Major Project Level:	Cummulative Major Project Monthly Cost Summary
CPRJ.1	Project Level:	Annual Project Cost Summary
CPRJ.2	Project Level:	Cummulative Annual Project Cost Summary
CPRJ.3	Project Level:	Monthly Project Cost Summary
CPRJ.4	Project Level:	Cummulative Monthly Project Cost Summary
CNT.1	Sub Project/ Contractor Level:	Monthly Sub Project/Contractor Cost Summary
CNT.2	Sub Project/ Contractor Level:	Cummulative Monthly Sub Project/ Contractor Level Cost Summary

C Allocation Reports

APRG.1	Program Level:	Annual Program Resource Summary
APRG.2	Program Level:	Monthly Program Resource Summary
AMPR.1	Major Project Level:	Annual Major Project Resource Summary
AMPR.2	Major Project Level:	Monthly Major Project Resource Summary
APRJ.1	Project Level:	Annual Project Resource Summary
APRJ.2	Project Level:	Monthly Project Resource Summary
ACNT.1	Sub Project/ Contractor Level:	Annual Sub Project/Contractor Resource Summary
ACNT.2	Sub Project/ Contractor Level:	Monthly Sub Project/Contractor Resource Summary

Some examples of typical graphics output are presented in Figures 8, 9 and 10 for scheduling, cost and allocation outputs respectively.

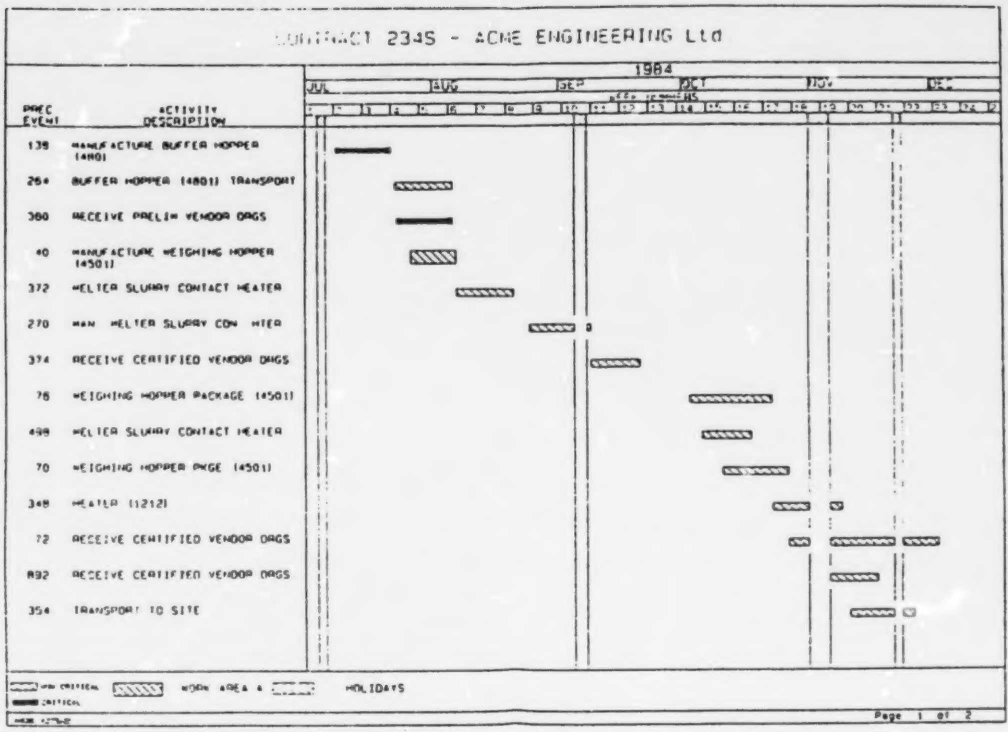
2.4 EDP SOLUTIONS

2.4.1 Key Considerations

From a technical standpoint, there are a variety of ways in which alternative hardware and software offerings can be combined to meet the requirements outlined earlier. These differ in a variety of aspects, but there are three that are key.

- **Stand alone capability:** Managers generally prefer access to a stand alone computing facility over which they themselves, can exercise administrative control, in preference to a more capable and flexible mainframe based systems.

- **Good quality graphics capability:** Project management data may be ignored unless it can be presented in a clear and easily digestible format. This is particularly true, since the information often forms the centrepiece of discussion between two or more managers. Most systems offer quasi graphical output in the form of charts and graphs produced from a line printer. Almost without exception, those



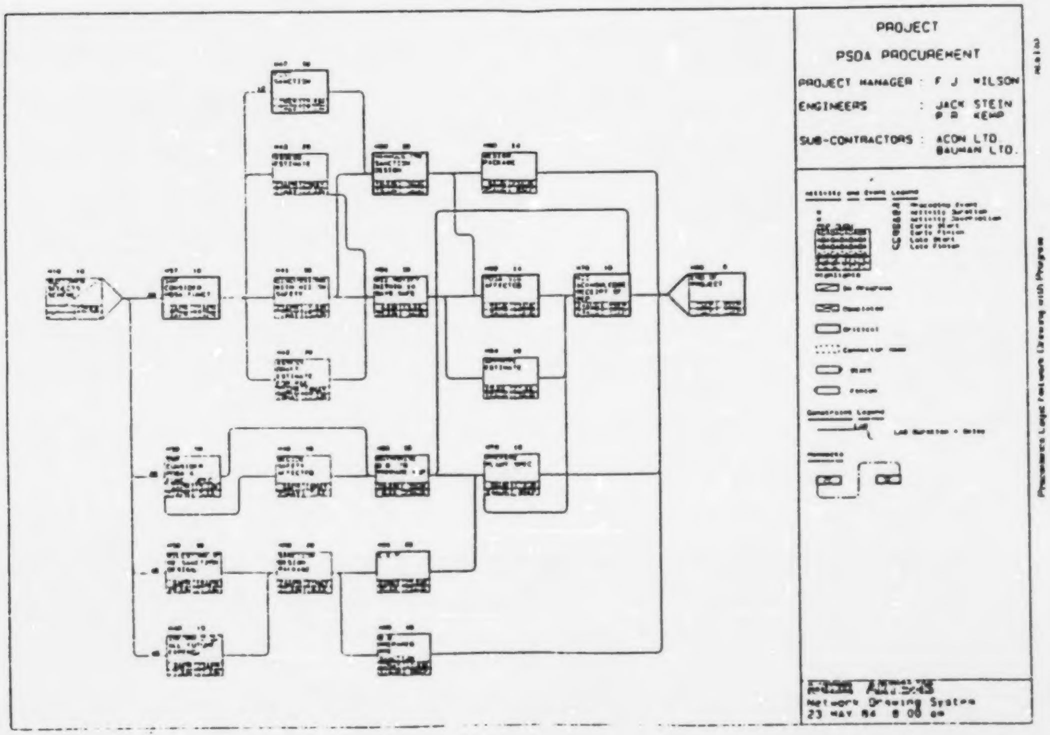

PROJECT
PSDA PROCUREMENT
PROJECT MANAGER : F J WILSON
ENGINEERS : JACK STEIN P R KEMP
SUB-CONTRACTORS : ACON LTD BAUMAN LTD.
Network Drawing System
23 MAY 84 8 00 am

FIGURE 8: SAMPLE GRAPHICS OUTPUT FORM SCHEDULING COMPONENTS

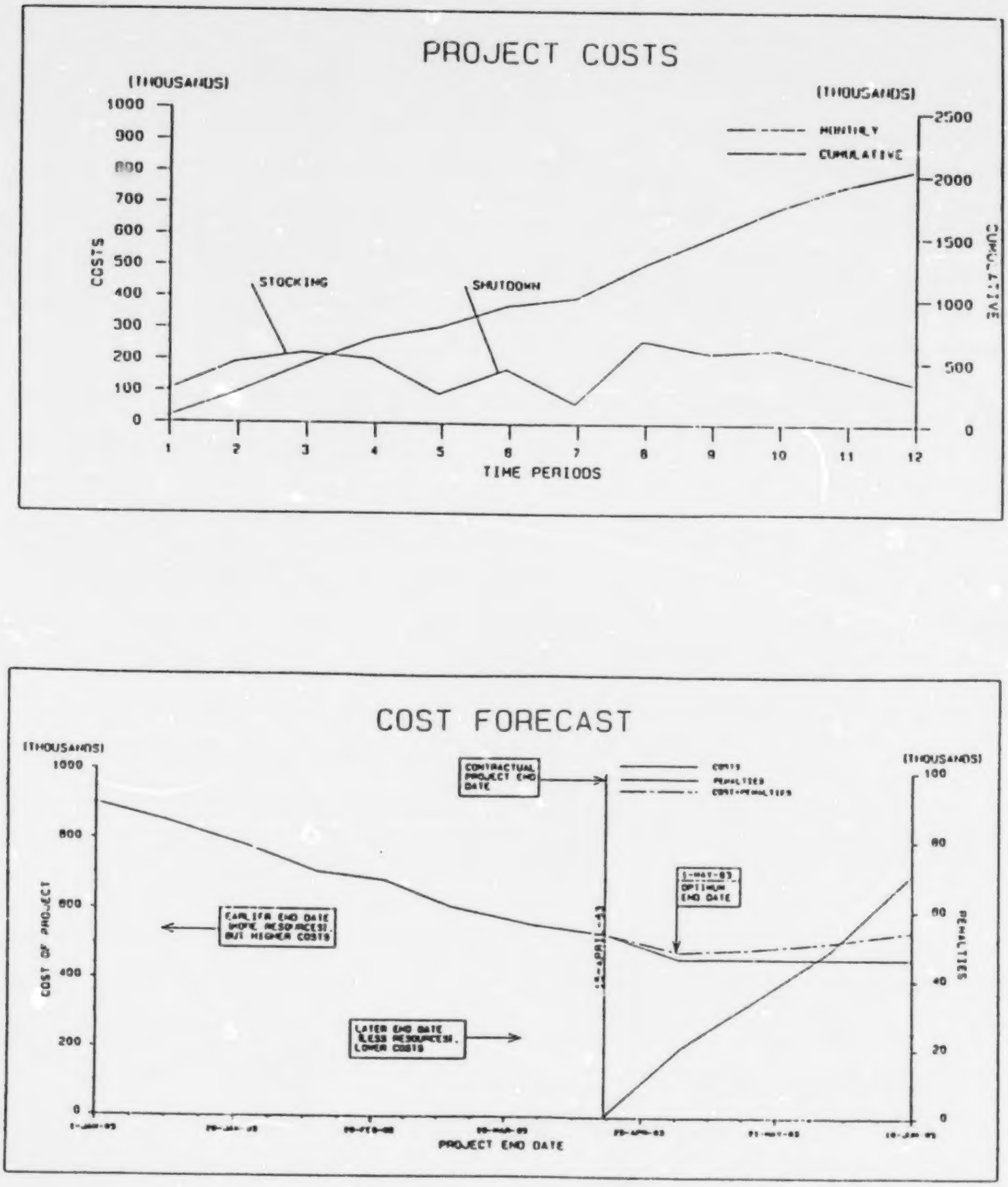
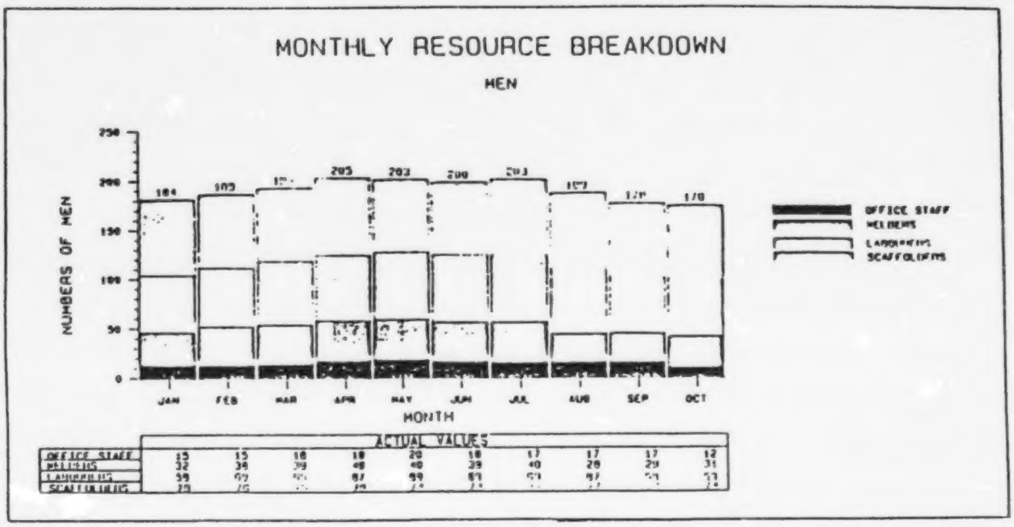


FIGURE 9: SAMPLE GRAPHICS OUTPUT FROM COSTING COMPONENT



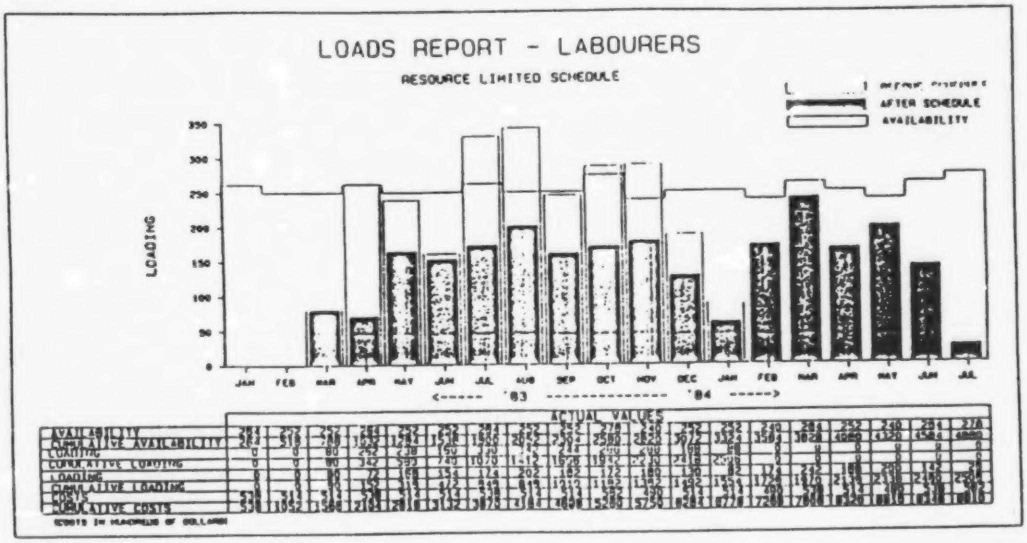


FIGURE 10: SAMPLE GRAPHICS OUTPUT FROM ALLOCATION COMPONENT

renderings lack visual appeal, are difficult to read and do not meet the demands of managers. If a picture is to be worth a thousand words it must be clear. To achieve this, requires graphics software and graphics plotters.

- **An integrated database:** This is a database in which each required data element is stored and is stored in only one location. Users authorized to access a particular data element necessarily all deal with the same data.

As will be seen, a variety of hardware and software offerings are available to meet these needs. The tradeoffs are between cost, capability, and technical complexity.

Over the long term, we believe that the CAS Program will evolve towards an integrated project management support system in which all data records are held centrally (to avoid duplication and the inevitable offsets that otherwise result, as well as to facilitate roll ups). Such a system would consist of a centralized database with distributed micro processors and graphics capability.

2.4.2 Types of Systems Available

There are a variety of systems available for schedule, cost and allocation control of projects. These systems are available as 'off the shelf' software packages to run on mainframes, mini's and/or micros. Typically mainframe packages offer greater capability in terms of the computational features available and capacity as well as in the range and flexibility of output reports. At the same time however, mainframe or mini system based packages are more time consuming to master. At the other end of the spectrum are micro computer software packages. These systems offer less capacity and restricted capability compared with mainframe or mini based systems. In particular, few of these systems offer sophisticated output, and the flexibility for developing user oriented special purpose data structures is usually absent. Table 1 summarizes.

TABLE 1: SUMMARY OF OPTIONS

Typical Features	Micro	Mini or Mainframe
Activities	10,000	32,000
Dependencies	128 4 per activity	?
Arrow Diagram Network/ Precedence Diagram Method	usually one or the other	usually both
Resource Allocation	yes	yes
Graphics Capability	usually restricted to printers	yes

An important hybrid is the combination of mainframe with stand alone micro. This approach offers the mainframe advantages in policy capability along with standalone simplicity for limited applications. It would be tempting therefore, to select a system that offers standalone capabilities with the option at a later stage of integrating these into a mainframe based system. Unfortunately, systems that we have identified that would allow this to happen, do not offer standalone graphics (i.e. graphics output is available only with the micro acting as a dumb terminal slaved to a mainframe).

2.4.3 Available Software

A multitude of software packages are available for both micro and mainframe applications. (A list of candidate packages is contained in Table 2). While this list is fairly extensive, the number of acceptable options is relatively small. For instance, few mainframe packages offer an associated standalone micro version that is fully compatible. ARTEMIS is the only one of this type that we found. Of the large number of micro based packages, few offer a standalone graphics capability, PROMIS and PRIMAVERA are the only examples that we found. PMS II a micro based package is currently used in CATA and accordingly we narrowed the field to these four systems:

- PROMIS and PRIMAVERA currently offer a broad range of schedule and cost control features with graphics
- PMS II offers a broad range of schedule and cost control features with standalone graphics promised for early 1985
- ARTEMIS is a high capability mainframe based system available also as a standalone system on a micro. However the micro based system does not offer standalone graphics.

Table 3 compares the features of PMS II, PROMIS, ARTEMIS, and PRIMAVERA. We are aware of the steps already taken to standardize on PMS II for project management in CATA. However, PRIMAVERA and PROMIS offer two advantages over PMS II. First, they are currently available with a standalone graphics capability, second they accept network definitions using the precedence network convention.

TABLE 2: LIST OF PACKAGES

Main Frame	Micro Computer
CIPREC	PMS II
ARTEMIS	PRIMAVERA
PMS IV	Harvard Business Manager
EPOXY	Microplanner
VMAS	PROMIS
ITSI	PLANTRAC
Project 2000	PER MASTER
MAPP	The Confidence Factor
EZ Pert	Gantt - It
PROJACS	Micro Gantt XT
	Pathfinder
	Pro-Ject 6
	Project Manager Workbench
	MILESTONE
	Critical Path Scheduling
	Micro PERT0
	Micro PERT1
	Micro PERT2
	PERT/CPM
	Project Analysis
	PROSCHED
	JOBTRAK

TABLE 3: COMPARISON OF THREE MICRO BASED PROJECT SCHEDULING AND CONTROL PACKAGES

	PMS II	ARTEMIS	PRIMAVERA	PROMIS
NETWORK PROTOCOL	• ACTIVITY ON ARROW	• PRECEDENCE • ACTIVITY ON ARROW	• PRECEDENCE • ACTIVITY ON ARROW	• PRECEDENCE
HARDWARE REQUIREMENTS	• ANY MICROCOMPUTER • AT LEAST 64K RAM • 400K IN 2 DRIVES OR HARD DISK • MONITOR - 80 CHARACTER, 24 LINE, 'ERASE TO END OF LINE', ADDRESSABLE CURSOR • CP/M, MP/M, MS-DOS, PC-DOS	• 16 BIT 8088 MICROCOMPUTER • 256/320K RAM • 2 DISKETTE DRIVES, OR 1 DISKETTE DRIVE AND HARD DISK • HIGH RESOLUTION MONOCHROME OR COLOUR RGB MONITOR 80 COLUMNS, 25 ROWS • PC-DOS OR MS-DOS 2.0 OR GREATER	• IBM-PC/XT OR COMPATIBLE • 512K RAM • 10 MEGABYTE HARD DISK • PC-DOS OR MS-DOS 2.0 OR GREATER	• IBM PC/XT OR EQUIVALENT • COLOUR OR MONOCHROME DISPLAY • 1 FLOPPY DRIVE AND HARD DISK • 320K MEMORY • CP/M-86 OPERATING SYSTEM
NETWORK CAPABILITIES	• 2700 ACTIVITIES • UP TO 100 HOLIDAYS, OF UP TO 100 DAYS • US AND INTERNATIONAL DATE FORMATS • 3-7 DAY WORKWEEK • CAN BE INTERFACED WITH dBASE II • MODES: ACTUAL START/FINISH, DAYS REMAINING, PERCENT COMPLETE.	• 64 FIELDS PER DATA SET • 4 SORT FIELDS • 1000 RECORDS PER DATA SET • 7000 FIELDS PER DISKETTE • 21000 FIELDS PER MEGABYTE (ON XT SYSTEM) • MAXIMUM OF 8 ALPHANUMERIC CHARACTERS PER FIELD NAME • MAXIMUM OF 250 CHARACTERS PER TEXT FIELD • DATE LIMITATION 01/JAN/1900 TO 31/DEC/2039	• 10000 ACTIVITIES 20 SORT FIELDS • UNLIMITED SUCCESSORS IN PRECEDENCE NETWORKS • ALLOWS OUT OF SEQUENCE PROGRESS • UP TO TWO TARGET SCHEDULES • ADJUSTS COSTS FOR INFLATION	• 800 ACTIVITIES PER NETWORK UNLIMITED SUBNETWORKING • UNLIMITED SUCCESSOR/PREDECESSOR • MULTIPLE CALENDARS • MULTI-PROJECT SCHEDULING CAPABILITIES
RESOURCE CAPABILITIES	• 96 RESOURCE CENTRES SPECIFYING CAPACITY,COST,BURDEN RATE	• RESOURCE DATA MAY BE COLLECTED AND ASSIGNED AGAINST ANY ACTIVITY • UP TO 64 RESOURCES PER ACTIVITY • UP TO 256 RESOURCE TYPES PER NETWORK	• UP TO 8 CHARACTER CODING • MEASURE IN ANY QUANTIFIABLE UNITS • SPECIFY USAGE AND AVAILABILITY IN EACH TIME PERIOD • SPECIFY RESOURCE PRIORITY FOR AUTOMATIC RESOURCE LEVELING	• LABOUR, MATERIALS, EQUIPMENT MANAGEMENT • UNLIMETED RESOURCE TYPES PER PROJECT • USER DEFINABLE UNITS OF MEASURE • RESOURCE USAGE TRACKING • MULTIPLE WORK BREAKDOWN STRUCTURES • FLEXIBLE FORECAST TO COMPLETE ALGORITHMS
REPORTS	• MEETS GOVERNMENT CONTRACT REPORTING REQUIREMENTS	• CUSTOMIZED REPORTS	• CUSTOM REPORT SPECIFICATIONS COMPATIBLE WITH DOD, DOE, COE	• OVER 40 STANDARD REPORTS • OPTIONAL USER DEFINABLE REPORTS • COMPLIES WITH STANDARD DOD REQUIREMENTS • ZOOM AND PAN CAPABILITIES ON ALL SCREEN GRAPHICS
PLOTTER GRAPHICS	• BEING DEVELOPED	• REQUIRES INTERFACE WITH MAINFRAME	• AVAILABLE	• FULL COLOUR SCREEN AND PLOTTER OUTPUTS -GANTT CHARTS -NETWORK DIAGRAMS -CASH FLOW HISTOGRAMS
COST	• $2800	• *	• $3600	• $3900

This approach avoids complications with network definition that develop with the 'activity on arrow' approach when an activity completion enables two or more succeeding activities to begin, but where other different conditions must also be met. In these cases, using the activity on arrow approach, a dummy activity must be introduced to replicate the desired logic. Those dummy activities clutter the network diagram and interfere with other output reports.

ARTEMIS offers the advantage of stand alone operation on a micro plus the ability to develop easily into an integrated database system. As a micro based standalone system however, ARTEMIS does not offer a local graphics capability. Plotting must be done either remotely at a mainframe, or by linking a local plotter to a remote mainframe. For this reason the ARTEMIS option is less attractive.

3.0 CONFIGURATION MANAGEMENT

Configuration management is a technical and administrative process whereby

- functional and physical characteristics of selected hardware and software are documented (configuration identification)
- changes to these characteristics are controlled through a set of defined procedures (change control). These have already been established in CATA and are detailed in TP 2734 & 1-8 POPP which describes the role of the National Airspace System Configuration Control Board (NASCCB) and design change procedures. (NASCCB is only applicable to a small group of special systems and it may no longer apply as F.E.S.D. now controls hardware and software status.)
- documentation changes are made arising from changes to the functional and physical characteristics of selected equipment* (configuration update)
- a record is maintained of the status of proposed, approved, impending and completed changes (configuration status accounting). This record identifies the system configuration, and the status of changes both proposed and approved in terms of their priority, schedule and progress.
- a follow-up process of reviews and audits is conducted to ensure that equipment conforms with specifications and requirements (quality assurance).

Figure 1 illustrates the linkages between the above functions.

---

* The term equipment is used here to designate both hardware and software.

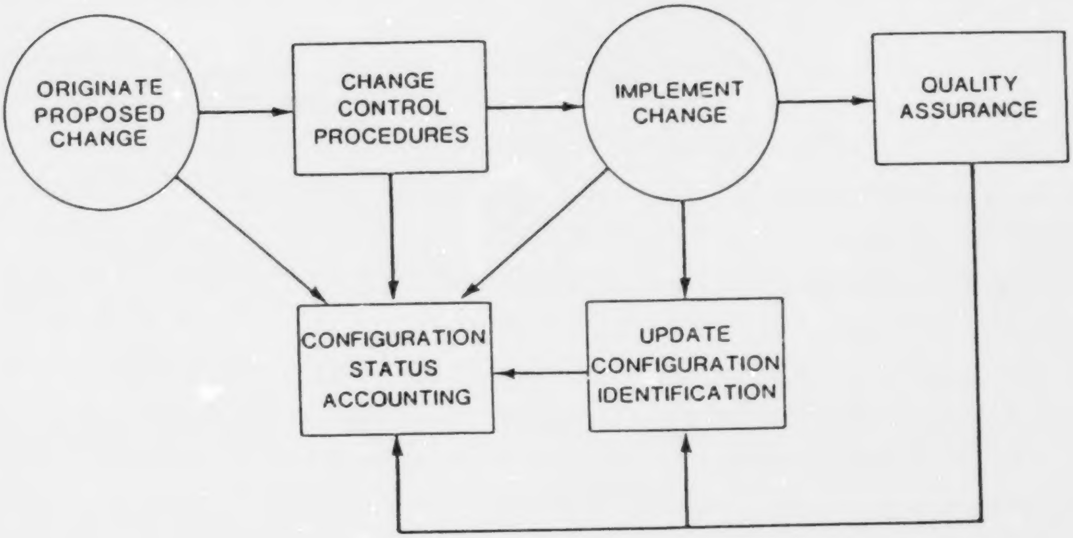

ORIGINATE PROPOSED CHANGE
CHANGE CONTROL PROCEDURES
IMPLEMENT CHANGE
QUALITY ASSURANCE
CONFIGURATION STATUS ACCOUNTING
UPDATE CONFIGURATION IDENTIFICATION

FIGURE 1: CONFIGURATION MANAGEMENT PROCESS

3.1 TOOLS FOR CONFIGURATION MANAGEMENT

Tools to assist the CM function consist of:

- An array of systems and procedures that govern the change control process along with procedures to assist in the preparation of management reports detailing in summary form the status of all change actions.
- specialized software to update and maintain the configuration descriptions of hardware as well as of software.

Each of these will be dealt with separately.

3.1.1 Systems and Procedures

Paperwork systems and procedures that assist the flow of information through the change control process are, of course, determined by the nature of that process. In CATA the basic elements of a configuration control process are in place (CATA Policy CA215) and configuration management is pursued at various points in the organization.

Figure 2 depicts the flow of CM activities and approvals from the generation of an Unsatisfactory Condition Report and/or Change Proposal through generation of a change order, implementation and quality assurance. This is a simplified description of the CATA process based on CATA Policy CA215. (Only applicable for specific equipments under NASCCB. Other equipments see TESP 2-5 ADMIN. Sec 12.)

A wide range of ancillary standards and proceduree are required to ensure that configuration control is effectively exercised. For instance, standards are needed for describing the configuration at selected points in the life cycle (at various design and product baselines).

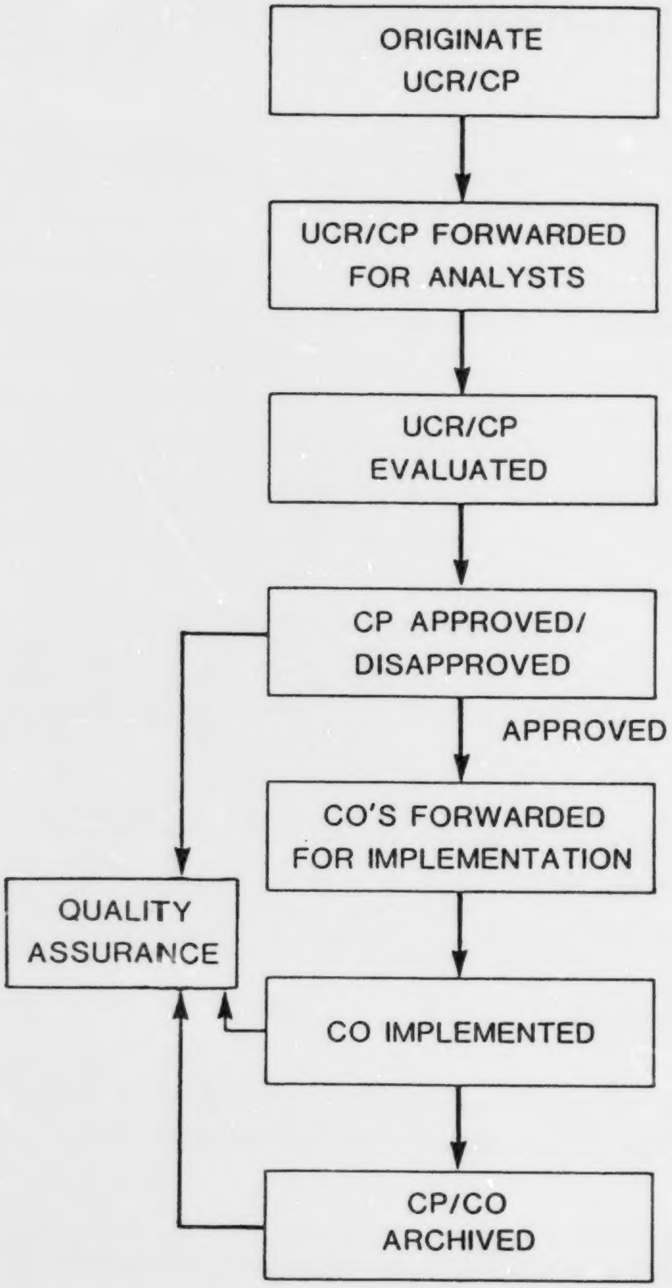

ORIGINATE UCR/CP
UCR/CP FORWARDED FOR ANALYSTS
UCR/CP EVALUATED
CP APPROVED/ DISAPPROVED
APPROVED
CO'S FORWARDED FOR IMPLEMENTATION
QUALITY ASSURANCE
CO IMPLEMENTED
CP/CO ARCHIVED

FIGURE 2: THE FLOW OF ACTIVITIES AND APPROVALS FOR CONFIGURATION CHANGE CONTROL.

Table 1 describes the configuration description documentation typically associated with various life cycle phases and associated baselines.

A range of measures have been identified to enhance CATA's existing system. These include:

- changes to fill gaps in current procedures for specifying documentation requirements for configuration items,
- introducing a complete set of guidelines to cover configuration item (CI) identification (specification, equipment, drawing and part etc.)
- the introduction of specifications for all change documents such as contract change notices, engineering change, follow up and stop orders and
- the elimination of overlaps and duplication in the specification of the requirements for configuration management (CM). These recommended enhancements are contained in a memo from DGRP/X to DFS. (Oct. 1984)

These recommendations lead towards standardizing the language and procedures for configuration management by establishing uniform standards for items shown in Table 2.

3.1.2 Status Accounting

Status accounting is the process by which configuration change activity is recorded, stored in a database, and reported upon.

This entails maintaining a record of configuration change activity, (the changes themselves and the volumes of transaction flows in the CM system). The changes are stored in a way that enables the updated configuration identification to be readily identified, and reports are available that summarize transaction flows, detail individual transactions, and describe or point to the updated configuration identification.

TABLE 1: CONFIGURATION ITEM DOCUMENTATION FOR VARIOUS LIFE CYCLE PHASES AND ASSOCIATED BASELINES

Life Cycle Phase	Begins From Baseline as indicated	This Baseline Contains
Conceptual	Functional	System specification Work Statement Design Criteria Trade-off Analyses
Definition	Allocated	Part 1 Specifications Interface documents
Preliminary Design	Design	Engineering model drawings Qualification test plans Engineering model test Procedures layout drawings Indentured drawing lists Advanced list of material Design review data Part 1 specification
Detailed Design	Development	Prototype drawing release Qualification test procedure Updated performance specification Initial design specification
Development	Product	Final test procedures Design specification complete Qualification test data Operational article drawing release
Production/ Installation & Test	Operational	Parts lists and specs current to release or delivery baseline Test data Maintenance manuals Training manuals

TABLE 2: CONFIGURATION IDENTIFICATION DOCUMENTS AND CONTROL DOCUMENTATION CONFIGURATION

- baseline documentation including
  - engineering/release*
  - drawings/software
  - specifications*
  - parts and data lists*
  - test procedures*
  - technical and operating manuals*
  - training manuals*
  - servicing manuals*
  - software documentation*

- control documents
  - unsatisfactory condition report*(UCR)*
  - change proposal (CP)*
  - engineering change documents
  - design change notice* (in FESD Design Change Memorandum See 1-8 POPP.)
  - engineering order
  - CCB directives*
  - contract change notice
  - follow up reports
  - deviations and waivers* (Defined in 1-8 POPP and DFS 1000)
  - stop order

- monitoring systems
  - equipment type numbers*
  - specification numbers
  - equipment numbers*
  - drawing and part numbers*
  - serial numbers*
  - interchangeability identification
  - UCR and CP numbers*
  - inventory control numbers*

- control document identification
  - change identification numbers
  - standard configuration identifiers
  - changes to specification numbers

- engineering change records
  - engineering order status list
  - engineering change proposal list
  - as planned list
  - as designed list
  - as built list
  - as modified list
  - configuration baseline index

---

* CATA has established standards for these items

3.1.2.1 Transaction Reporting

The required status information is depicted in Tables 3 for a given CI. The activity and approvals process described earlier in Figure 2, is the source of data for status accounting. This however is a generic depiction of the process. In actuality, UCR/CP's may originate from a wide range of sources. They may relate to a variety of CI's defined as part of different major projects, projects and subprojects/contracts. Status accounting must record status of change activity according to a vastly more detailed and wide spread information flow - differentiating among CI's and providing summary data by project, major project and for the program as a whole.

EDP support tools to assist this process have been developed by several users. Typically, however, the support tool must be closely tailored to fit the organization's process. This means that status accounting tools developed elsewhere are of doubtful applicability. By establishing a unique UCR/CP and CO identification system, along with the necessary data flow procedures and data base file definitions, the required status summary and tracking reports can be readily transferred to a database with a minimum of up front programming effort. Figure 3 illustrates the information flows involved.

A general purpose database system such as dBASE II, which operates on the IBM PC, would be suitable for this purpose.

3.1.2.2 Configuration Status Reporting

A further aspect of configuration status reporting is that it enables the current status of the CI to be determined by referencing all changes to baseline documentation (drawing and ancillary records, specification records, etc.), by keeping track of changes as they are implemented, and by reporting the current configuration. (See Figure 4).

TABLE 3: STATUS ACCOUNTING: TRANSACTION INFORMATION FOR A TYPICAL CI

A. TRANSACTION SUMMARY INFORMATION

Process Phase	No.
UCR/CP's active last report	___
UCR/CP's received since last report	___
UCR/CP's disposed since last report	___
UCR/CP's now active	___
- in analysis	___
- awaiting disposition	___
CO's active last report	___
CO's initiated since last report	___
CO's disposed since last report	___
CO's now active	___

B. TRANSACTION TRACKING INFORMATION

1. Identifying data, UCR/CP No. or CO No.

2. Status information	Date
submitted for evaluation	___
submitted approved	___
submitted disapproved	___
CO's issued	___
forwarded for implementation	___
implementation complete	___
archived	___

3. Baseline Impact	
scheduled inclusion into baseline	___
baselines to be changed	___
CI's affected	___

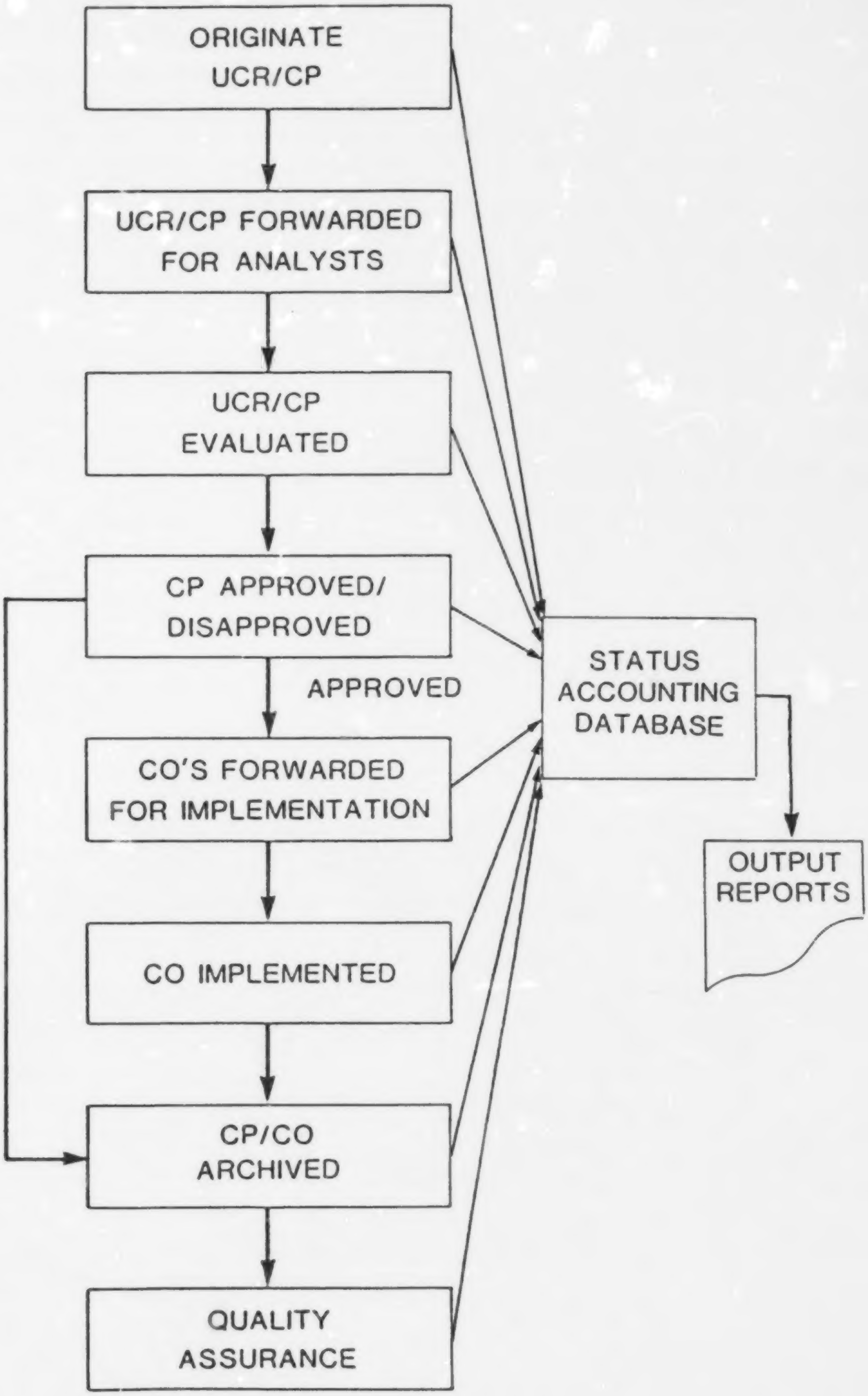

ORIGINATE UCR/CP
UCR/CP FORWARDED FOR ANALYSTS
UCR/CP EVALUATED
CP APPROVED/ DISAPPROVED
APPROVED
CO'S FORWARDED FOR IMPLEMENTATION
CO IMPLEMENTED
CP/CO ARCHIVED
QUALITY ASSURANCE
STATUS ACCOUNTING DATABASE
OUTPUT REPORTS

FIGURE 3: DATA FLOWS FOR STATUS ACCOUNTING

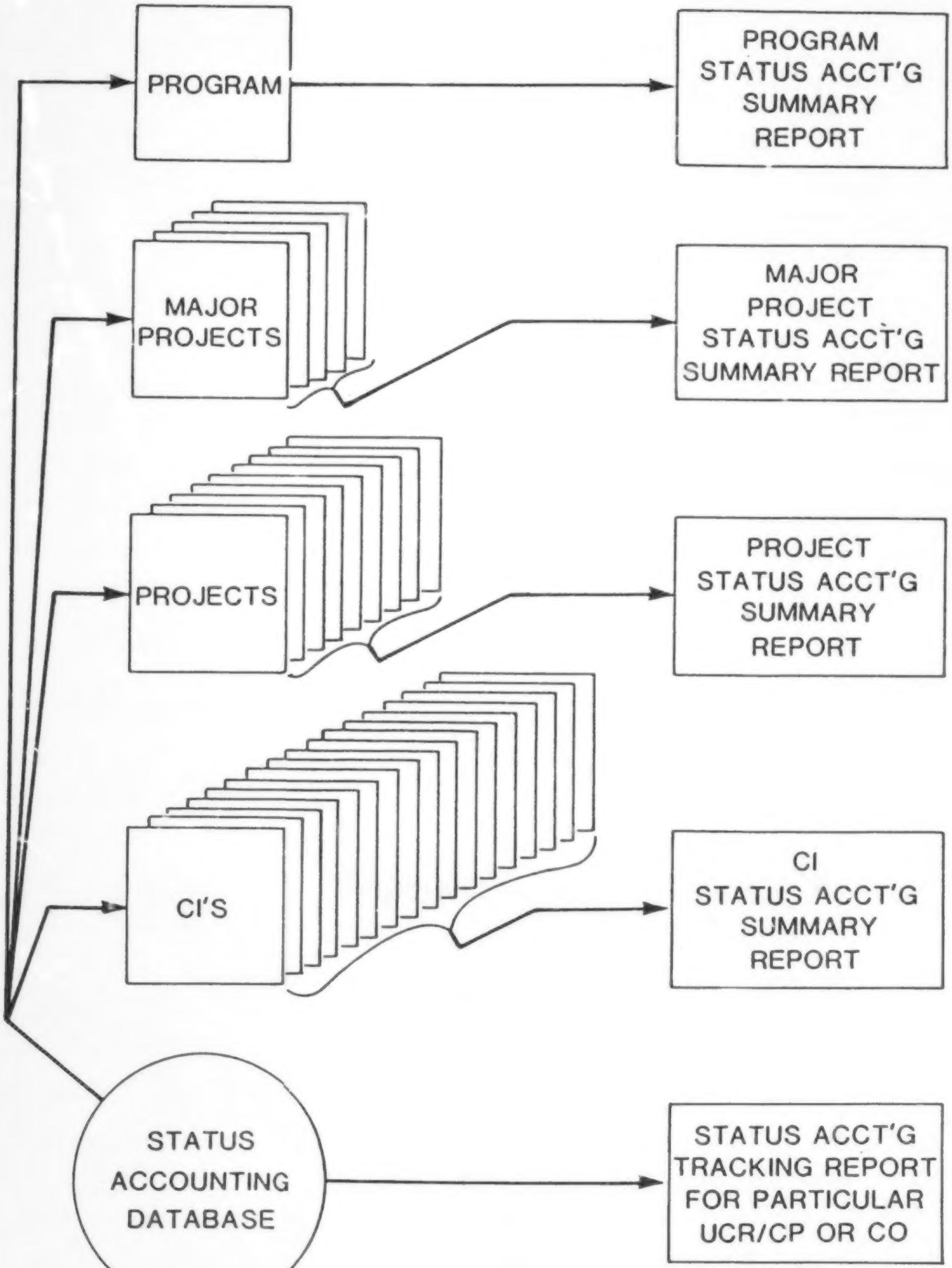

PROGRAM
PROGRAM STATUS ACCT'G SUMMARY REPORT
MAJOR PROJECTS
MAJOR PROJECT STATUS ACCT'G SUMMARY REPORT
PROJECTS
PROJECT STATUS ACCT'G SUMMARY REPORT
CI'S
CI STATUS ACCT'G SUMMARY REPORT
STATUS ACCOUNTING DATABASE
STATUS ACCT'G TRACKING REPORT FOR PARTICULAR UCR/CP OR CO

FIGURE 5: HIERARCHY OF STATUS ACCOUNTING REPORTS

(63) ⑰ ㊻

CONFIGURATION STATUS ACCOUNTING REPORT (U)

⑮

BASE LINE INDEX

⑩
AS OF 69 11 20

(51)
A-7B

④ CONFIGURATION ITEM IDENTIFICATION	(63) NOMENCLATURE	⑰ MILITARY SPECIFICATION NUMBER ⑯	⑩ DATE	㊲ MFG CODE
7051110	AIR VEHICLE	A-2729891444	670215	80378
7051111	AIRCRAFT COMMANDER TRAINER	A-1910314947511	650710	97928
7051112	POWER PLANT	PP-294992104-82	671112	00624
7051113	FIRE CONTROL	F-531642574772	670312	70709
7051114	NAVIGATION/GUIDANCE	N-1225[illegible]68311	661230	73030

FIGURE 5

CONFIGURATION STATUS (63) ACCOUNTING REPORT ⑰ (U) ㊻

CONFIGURATION ITEM IDENTIFICATION AND RELATED DATA

SUMMARY

(51)
SW - 42A

NOMENCLATURE - STOP WATCH (63)

CONFIGURATION ITEM BA0001A ④ 01 ⑤

⑮ SPECIFICATION ⑰ ⑯ CM112100-1A DATED 68 09 16 ⑩

⑮ DRAWING ⑰ 4M00000-101C WATCH STOP ㉘
DATED 68 09 16 ㉕

㉓ FSN (54) 0304Z ㉜ 2780-143-2901 (60) ㉖ ㉔

CONTRACTOR ㉜ KB WATCH MANUFACTURING CO. ㊲

PART NUMBER 081079-4M00000-101C (61)

⑩ AS OF 69 11 20 (53) ㊱ ⑪

㊷ CONTRACT NUMBER N000017-68-4444-A01 ㊵ ㊶ ⑧

⑥ CONTRACT BASIC LINE ITEM SERIAL NUMBER 0126

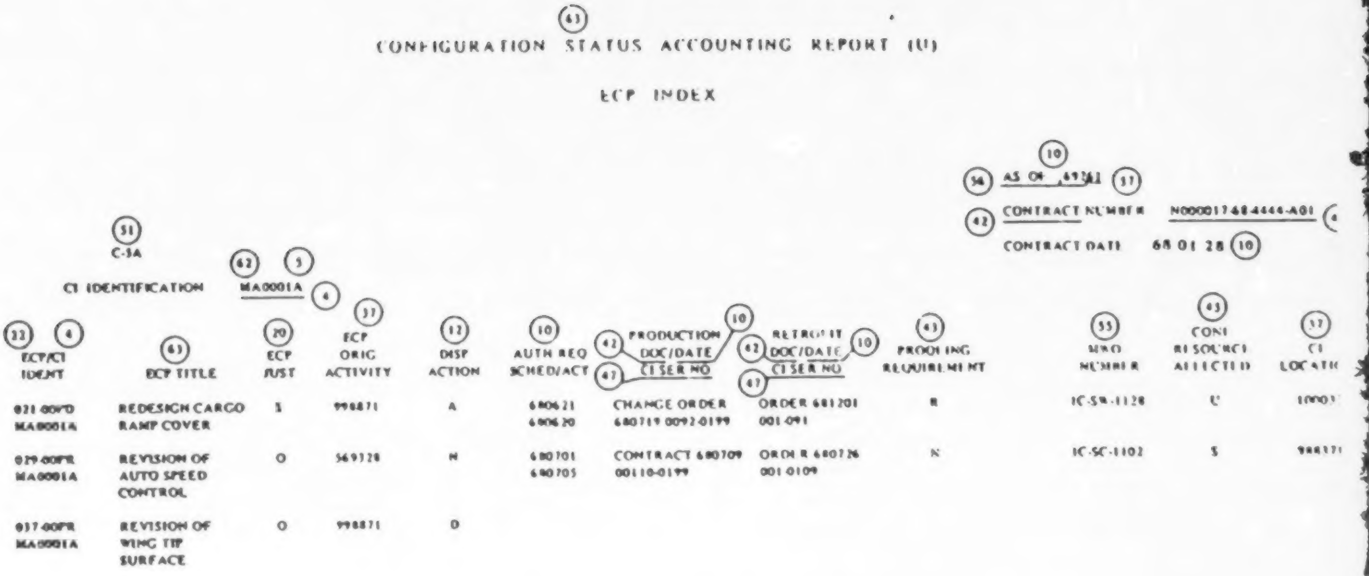
CONTRACT DATE 68 01 28 ⑩

CHANGE 68024AA ②

CHANGE DATE 68 06 24 ⑩

㉒ ECP IDENT	㉑ ACTION PRIORITY	(63) ECP TITLE	⑩ ECP SUB-MITTAL DATE	⑩ ECP APPROVAL DATE	(55) MODIFICA-TION WORK ORDER NUMBER	⑩ MODIFICA-TION WORK ORDER DATE	㉚ LOT SERIAL NUMBER	⑮ TECHNICAL PUBLICA-TION IDEN-TIFICATION	⑩ CURRENT TO DATE	⑩ REVISION SCHEDULE UPDATE	⑩ REVISION ACTUA UPDA
081079 ⑯ 0001-00F	R	CHANGE MAIN SPRING	680404	680627	7727	680628	012	⑬ ISW-42-R01 ⑭	680110	690215	690215
081079 0002-00F	U	REINFORCE STEM, ADD LUMINOUS DIAL AND BLUE SECOND HAND	690622	690811	7910	690813	020	ISW-42-R03	680110	690915	690915

FIGURE 6


(63)
(10)
(56)
(37)
(42)
(10)
(51)
(62)
(5)
(4)
(22)
(4)
(63)
(20)
(37)
(12)
(10)
(42)
(47)
(10)
(42)
(47)
(10)
(43)
(55)
(43)
(37)

CONFIGURATION STATUS ACCOUNTING REPORT (U)

ECP INDEX

AS OF 69361
CONTRACT NUMBER N000017484444-A01
CONTRACT DATE 68 01 28

C-5A
CI IDENTIFICATION MA0001A

ECP/CI IDENT	ECP TITLE	ECP JUST	ECP ORIG ACTIVITY	DISP ACTION	AUTH REQ SCHED/ACT	PRODUCTION DOC/DATE CI SER NO	RETROFIT DOC/DATE CI SER NO	PROOFING REQUIREMENT	MWO NUMBER	CONF RESOURCE AFFECTED	CI LOCATI
021-00VD MA0001A	REDESIGN CARGO RAMP COVER	I	998871	A	680621 680620	CHANGE ORDER 680719 0092-0199	ORDER 681201 001-091	R	1C-5W-1128	U	1000
029-00FR MA0001A	REVISION OF AUTO SPEED CONTROL	O	569128	N	680701 680705	CONTRACT 680709 00110-0199	ORDER 680726 001-0109	N	1C-SC-1102	S	99817
037-00FR MA0001A	REVISION OF WING TIP SURFACE	O	998871	D							

FIGURE 7

(63) ⑰

CONFIGURATION STATUS ACCOUNTING REPORT

CONFIGURATION ITEM INDEX

MODIFICATION STATUS

⑩ AS OF (53) 69 ㊱ NOV ⑪ 20

㊷ CONTRACT NUMBER N00017684444-A01

CONTRACT DATE 68 11 28 ⑩

(51)

㊿ ㉝ ㊽

AN/SPG-100 A

④ CII	㉑ ACT PRIOR	㉛ M/H PER UNIT	㊾ DOWN-TIME PER UNIT	㊹ QTY	⑩ GFE/KFE SCH/AC	⑩ SCH/AC	⑱ ECP IMPL	⑲ ECP INCORP LEVEL	㉗ EIC	㉞ MOD CONST IDENT ③	⑰	㉟	㉘ DWG IDENT	DWG CHANGE ⑬ TYPE SER NO ⑭	DWG CHANGE SCH/ACT DATE ⑩	㉘ SPEC IDENT
MA0001A	R	10	12	189	680722 680720	681010 681010	R	U	5ABZX10	P	ORDALT	1234	NA1130767123000	R 01	680301 680301	MIL-S8926398
MN0002A	R	7	10	148	680801 680801	681021 681018	R	D	GB510Z2	S	ORDALT	7121	NA1237203372698	A 03	680321 680320	MIL-S-2276981
MN0003A	R	23	30	39	680826 680825	681030 681028	R	U	CA02020	W	ORDALT	6002	NA3000724126321	M 02	680402 690410	MIL-S-731267123
MN0006A	U	50	62	201	680921 680920	681102 681104	U	I	FC11000		NONE		FA9321244611169	S 01	680409 680409	MIL-S-671103
MN0007A	E	9	11	27	680930 681003	681109 681109	E	U	DB14XX2	P	ORDALT	5008	AN5330696111624	R 03	680511 680510	MIL-S-6261178

FIGURE 8

STATUS REPORT OF ENGINEERING CHANGE PROPOSALS - IN PROCESS

SMS-TARTAR 680930

㉒	EQUIPMENT ④ ⑤	DATE ⑩	⑰ DATE	DATE	DATE	DATE	DATE	DATE	DATE	DATE	DATE	DATE	DATE	DATE	DATE	⑰ DATE	(55) ORDALT NUMBER	⑫ CODE
44114- 312F	BA001A 01 Guided Missile Launching System MK 13 ㉘ MOD 0	44114 680404	11001 680404	NA	44114 680404	11001 680428	63062 680429	63063 680501	11001 680503	11001 680515	11006 680518	11001 680516	11001 680516	11001 680525			7049	E-Emergency ㉑ 680429
54326- 18981F	C0021B 03 Computer MK 118 MOD 2	54326 680405	11001 680406	NA	54326 680405	63063 680415	63062 680420 (D)	63063 680415 (D)	11001 680419	11001 680425	11006 680501	11001 680503	11001 680505	11001 680510	11001 680515 (D)			D Routine ㉑
11001- 1-0335F	BX636C 05 Radar AN/SPG-55A	11001 680516	NA	NA	43680 680520	53063 680605	11001 680516	63063 660520	11001 680516	11001 680516	11006 680529	11001 680530	11001 680615	11001 680620	11001 680715	11001 680720		E Routine ㉑
68993- 6107F	DP340A 01 Weapons Direction Equipment MK 1 MOD 0	68993 680812	11001 680819	NA	68993 680812	63063 680829	63062 680830	63063 680915	11001 680825	11001 680826	11006 660920	11001 680925	11001 680925	11001 681001	11001 681002	11001 681003	8309	A Routine ㉑
67888- 338F	RM001E 10 Rocket Motor Inert Assy. MK 27 MOD 3	67888 680910	11001 680915	NA	67888 680910													U Routine ㉑

Enclosure (2)

FIGURE 9

3.2 ISSUES FOR CATA REGARDING CONFIGURATON MANAGEMENT

All of the activities required to pursue configuration management are currently in place. However, there are a variety of issues that need to be dealt with as a basis for further defining how CM is to operate. These really need to be resolved as a basis for introducing more advanced tools.

1. Since much of the equipment currently installed by CATA has not been subject to CM. The question arises whether to attempt to bring this equipment into CM or to leave it out. The task of bringing it in would be a monumental one and efforts expended here might detract from the resources available to ensure that new equipments are brought under C.M.

2. Contractors have their own systems for configuration management. These systems typically result in the same end product - a specification of a CI baseline that reflects precisely the actual CI. In acquiring a CI, CATA requires that the CI baseline be specified in a manner that will enable subsequent CM activity to be carried out efficiently. To an increasing extent, this informaion will be available in machine readable form. Current CATA systems are not well adapted to take advantage of this.

3. Development of a standardized system such as ANSI 32.16 1975 for identifying parts, components, sub assemblies, assemblies, systems and equipments. Currently Telecommunication and Electronics Standards and Procedures (TESP'S) detail a numbering system for categorizing all information pertaining to the life cycle management of systems. Use of NATO part numbers instead of manufacturers' numbers would be a step in this direction. (A major benefit of a unified parts identification system is the reduction in the numbers of parts which must be held in stock for repair.)

4. A wide range of standards for configurations management have been developed by the US military. These include:

MIL-STD-480/483: Configuration Management

MIL-STD-499: Engineering Management

MIL-STD-1679: Software Development

MIL-STD-1521: Technical Reviews and Audits for Systems Equipments and Computer Programs

The requirements setout in these US MIL-STDs are quite detailed. Required is work by CATA to determine whether these specifications are suitable to CATA's real needs.

5. A variety of standardized configuration management reports are specified in MIL-STD-482. These reports are aimed at providing:

- Approved configuration identification
- Status of proposed changes
- Implementation status of approved changes

The actual reports are shown in Figures 5 to 9 and are described below.

Base Line Index: identifies CI, its specification number and manufacturing code.

Configuration Identification and Related Data: contains various identifying data along with a list of related CPs and their status as regards modification and documentation revisions.

ECP Index: contains a list of all CP's against a CI.

Modification Status: shows the status of modifications against a particular equipment

4.0 LIFE CYCLE SUPPORT TOOLS

4.1 PROCESS

Life cycle costs are required at increasing levels of precision from R&D through to the acquisition stage. There are three principal alternatives for developing cost estimates as follows:

1. through examining identical or comparable equipment experience elsewhere
2. by requesting industry sources to provide price and availability (P&A) submissions
3. by developing independent cost estimates using standard industrial cost estimating techniques.

Where radically new equipment* is involved, suitable precedents may not exist. In these cases CATA requests industry sources to provide P&A submissions. This places CATA in the hands of industrial suppliers unless independent cost estimates are available. Moreover, since cost estimating is itself a time consuming and expensive procedure, there can be some legitimate doubt as to whether P&A submissions receive the degree of attention from potential suppliers, needed to ensure the requisite accuracy.

Accordingly, for cases where no suitable cost precedent exists, and where P&A costing is judged to be unsuitable for planning and decision making purposes, an independent means for arriving at equipment LCC's is required.

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* Equipment is used here to designate hardware and software.

4.2 SUPPORT TOOLS

A variety of tools are available to assist the LCC estimating process. Separate tools are usually used for hardware and software. Most general purpose tools focus on development and production costs although some also cover logistics support. A feature absent from many tools is provision for including actual operating (as distinct from logistics support) costs. This is presumably the case because operating costs are highly organization specific.

Tables 1 and 2 following list available tools for hardware and software respectively, along with an assessment of their areas of applicability.

The structure characteristic of most LCC models is shown in Figure 1. Some costs and parameters for estimating costs are fed in by the user (exogenous costs and parameters such as for instance development costs if they are known and the physical characteristics of the item). The costs proferred by the user are incorporated directly into the LCC calculation. At the same time, this cost and parameter data along with cost data from past experience stored within the model, is used by the model to generate other costs - production costs for example. Next, certain costs (such as training) may be estimated based on costs already calculated (such as production costs). The definition of how each cost is arrived at depends on the model and the availability of exogenous costs and parameters.

As with other models, the quality of cost estimates provided by LCC's depends heavily on the quality of data fed in. Typically, the data input requirements for LCC models are onerous. For instance, to calculate development and production costs for an electromechanical item under the RCA PRICE H system, requires the following data:

Production Quantity
No. of Prototypes Required
Weight (lbs)
Volume (cu. ft.)
Quantity

TABLE 1: HARDWARE LCC ESTIMATING SUPPORT TOOLS

System	Coverage				
	R&D	Production	Implementation	Operation	Support
PCA PRTCEH	X	X			
PCEM	X	X			
GENERAL DEVELOPMENT	X	X			

TABLE 2: SOFTWARE LCC ESTIMATING SUPPORT TOOLS

System	Coverage				
	R&D	Production	Implementation	Operation	Support
ARINC	X	X	X	X	X
ARON	X	X			
COCOMO	X	X		X	X
DOTY	X	X			
PUTNAM-SLIM	X	X		X	X
RCA PRICES	X	X			
RCA PRICES SL				X	X
WALSTON FELIX	X	X			
WOLVERTON	X	X			

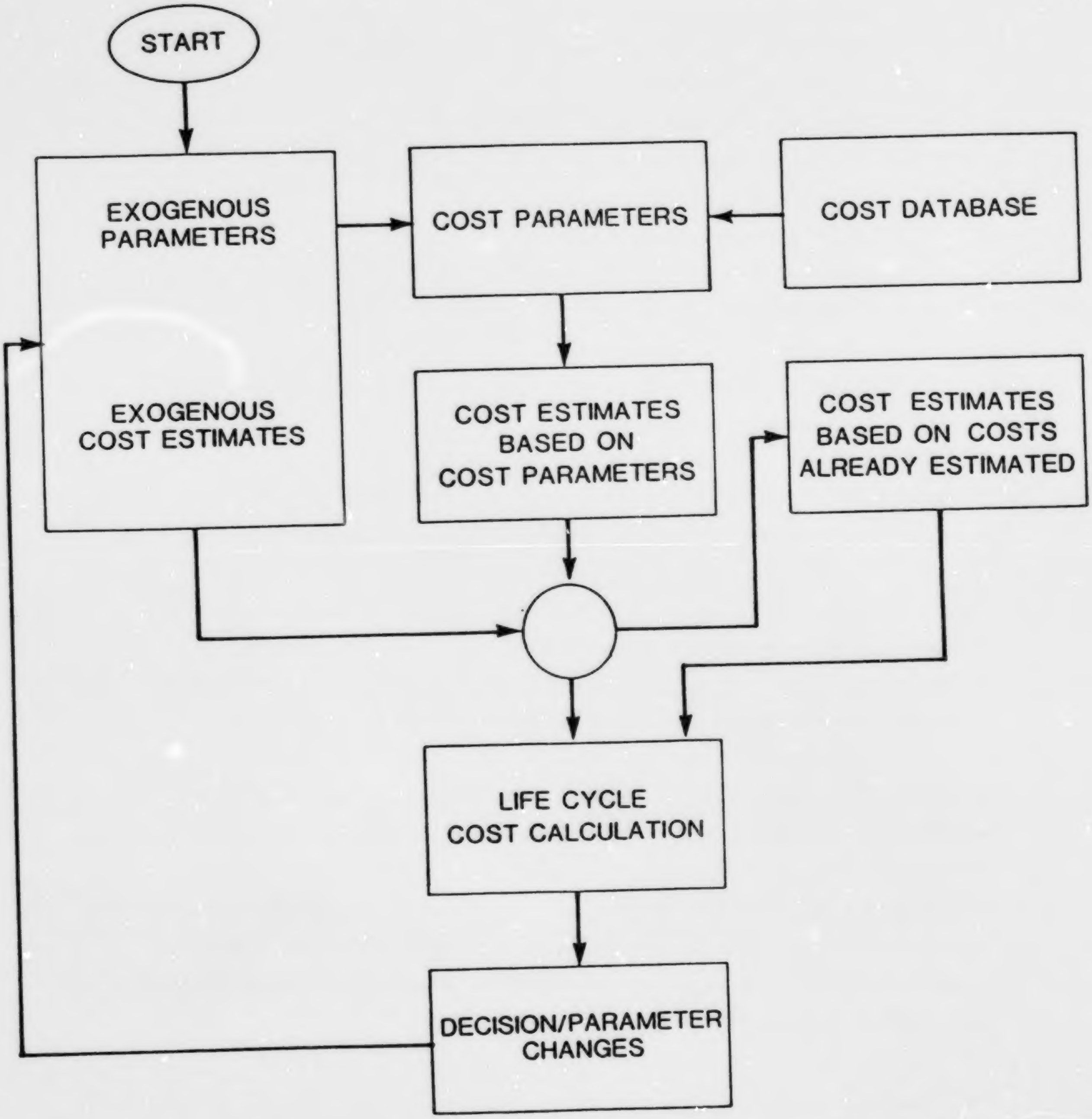

START
EXOGENOUS PARAMETERS
EXOGENOUS COST ESTIMATES
COST PARAMETERS
COST DATABASE
COST ESTIMATES BASED ON COST PARAMETERS
COST ESTIMATES BASED ON COSTS ALREADY ESTIMATED
LIFE CYCLE COST CALCULATION
DECISION/PARAMETER CHANGES

FIGURE 1: STRUCTURE OF A TYPICAL LIFE CYCLE COSTING MODEL

Integration factor (electronic)*
Integration factor (structural)*
Specification Level*
Mechanical structure wt.
Mechanical structure manufacturing complexity
Electronics weight per cu. ft.
Electronics manufacturing complexity*
Whether a design repeat
Whether new electronics
Time of development start
Time of development completion
Engineering complexity*
Time of production start
Time of production completion
Cost process factor*

Effective use of these models requires trained staff as well as a solid base for assumptions regarding timing, numbers of units required, etc.

Where operating and logistics costs are required, detailed operating scenarios and maintenance policies must be taken into account in calculating LCC's. Figure 2 shows the sequence of estimation steps required for one model developed by ARINC Research Corp.

Because CATA's particular approach to maintenance (use of RMMS for example) could have a significant bearing on logistics support costs, it is likely that any LCC estimation model will need to incorporate structural features that reflect this approach. This argues against the direct use of an 'off the shelf' model for operations and logistics support costing, and suggests the need for a model or models tailored to suit CATA's requirements.

---

* These items are estimated based on judgement. Instructions for estimating these factors are included with the PRICE system.

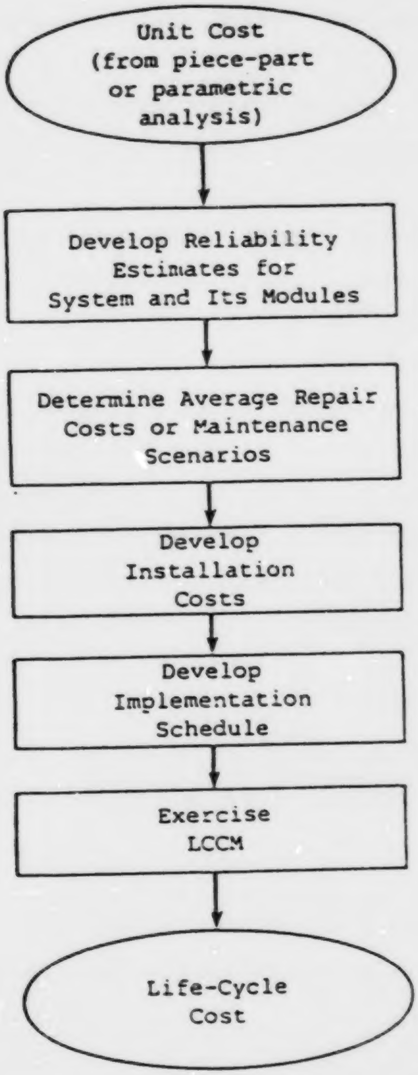

Unit Cost (from piece-part or parametric analysis)
Develop Reliability Estimates for System and Its Modules
Determine Average Repair Costs or Maintenance Scenarios
Develop Installation Costs
Develop Implementation Schedule
Exercise LCCM
Life-Cycle Cost

FIGURE 2: SEQUENCE OF ESTIMATION STEPS REQUIRED FOR ARINC RESEARCH MODEL

(SOURCE: ARINC SUPPLIED MATERIAL)

5.0 RISK MANAGEMENT

Program risk management offers a means for recognizing uncertainty in the decision making process and taking it into account.

1. It encourages a practice whereby uncertainties associated with inputs, assumptions and outcomes are specifically identified.

2. It offers a method for quantifying these uncertainties and for arriving at decisions in ways that explicitly recognize and take account of uncertainty.

Risk management can be applied at each program level. At the highest level, risk considerations can affect the decision of whether to proceed with the program. At an individual project level, risk management can be applied in support of technical decisions such as selection among competing technical alternatives or in support of managerial decisions (as when time, cost or performance uncertainties affect resourcing and scheduling decisions).

A wide range of analytic tools are available to assist in taking account of risk in decision making. Features of the risk analysis process are as follows:

1. A model is constructed relating outputs (i.e. variables on which a decision is to be based) to inputs (i.e. variables on which the outputs depend).

2. Typically, many of the inputs are uncertain. These uncertainties can nonetheless be identified and usually the uncertainty can be measured. For example, the cost of a project resource may not be known precisely in advance but can often be specified as a range of costs. The actual cost has a given probability of being within this range. Usually all costs in the range are assumed to have equal probability (although other probability specifications can be made).

3. Given the input data and estimates of the uncertainty of this data, the model is used to produce outputs, such as total program cost, with corresponding uncertainty estimates surrounding the output variables.

4. Analysis of these outputs and their corresponding uncertainties can lead in either of two directions. (See Figure 1) In the first instance it may suggest the need for risk avoidance or risk mitigation measures to reduce the uncertainty. In the second, it can serve as a basis for selecting among options.

The process of selecting from among various options, when uncertainty is involved, is the subject of decision analysis. Formal decision analysis seeks to deal with some of the difficulties that bedevil the practical decision process.

The first difficulty is how to decide among options that offer both quantitatively and qualitatively different outcomes (the apples and oranges problem). A variety of ranking and rating schemes are available to address this question. All of these rely on subjective judgement and are aimed simply at ensuring subjective consistency. Table 1 lists several common techniques along with examples of their use.

The second difficulty is how to incorporate the decisionmaker's propensity to accept risk into the process of choosing among alternatives. There are several approaches here: to select the alternative that maximizes the expected return in a statistical sense; to minimize the expected regret (i.e. to choose that alternative for which the worst that can happen times the likelihood of it happening is minimum); or to select the option for which the probability of the return exceeding a predetermined value is greatest. All of these methods are relatively straight forward to employ. What is difficult, is to develop a model that links a given set of inputs and their associated uncertainties, to a prescribed set of outputs and their uncertainties, as a basis for decision making.

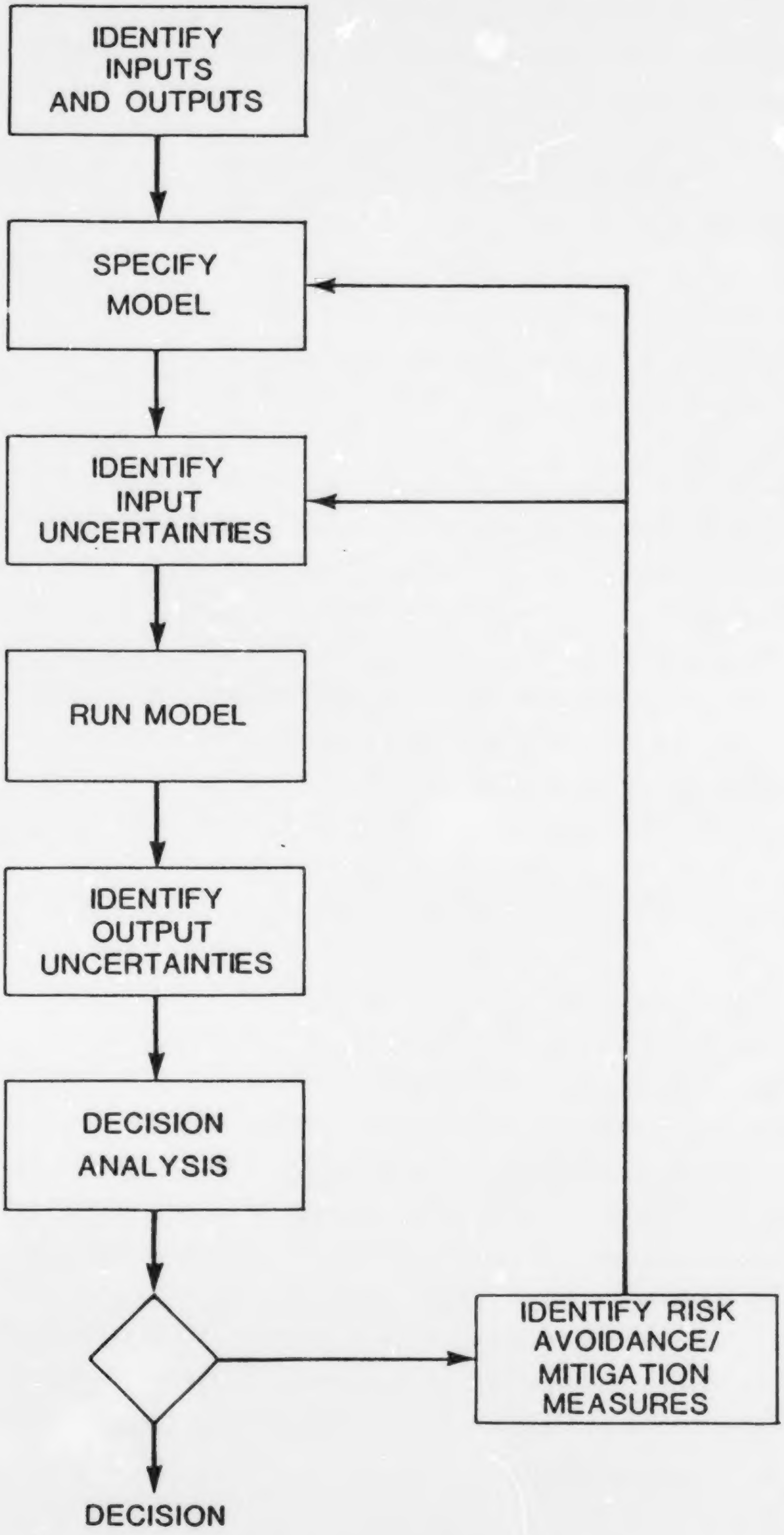

IDENTIFY INPUTS AND OUTPUTS
SPECIFY MODEL
IDENTIFY INPUT UNCERTAINTIES
RUN MODEL
IDENTIFY OUTPUT UNCERTAINTIES
DECISION ANALYSIS
IDENTIFY RISK AVOIDANCE/ MITIGATION MEASURES
DECISION

FIGURE 1: RISK MANAGEMENT PROCESS

5.1 RISK MANAGEMENT TOOLS (GENERAL)

Several approaches have been developed, both formal and informal, to support risk management.

5.1.1 Informal

This approach simply identifies things that can go wrong, and determines whether their effect on the outcome is likely to be significant. Where it is, the eventuality is recognized and articulated along with measures that can be taken to either avoid or mitigate the risk.

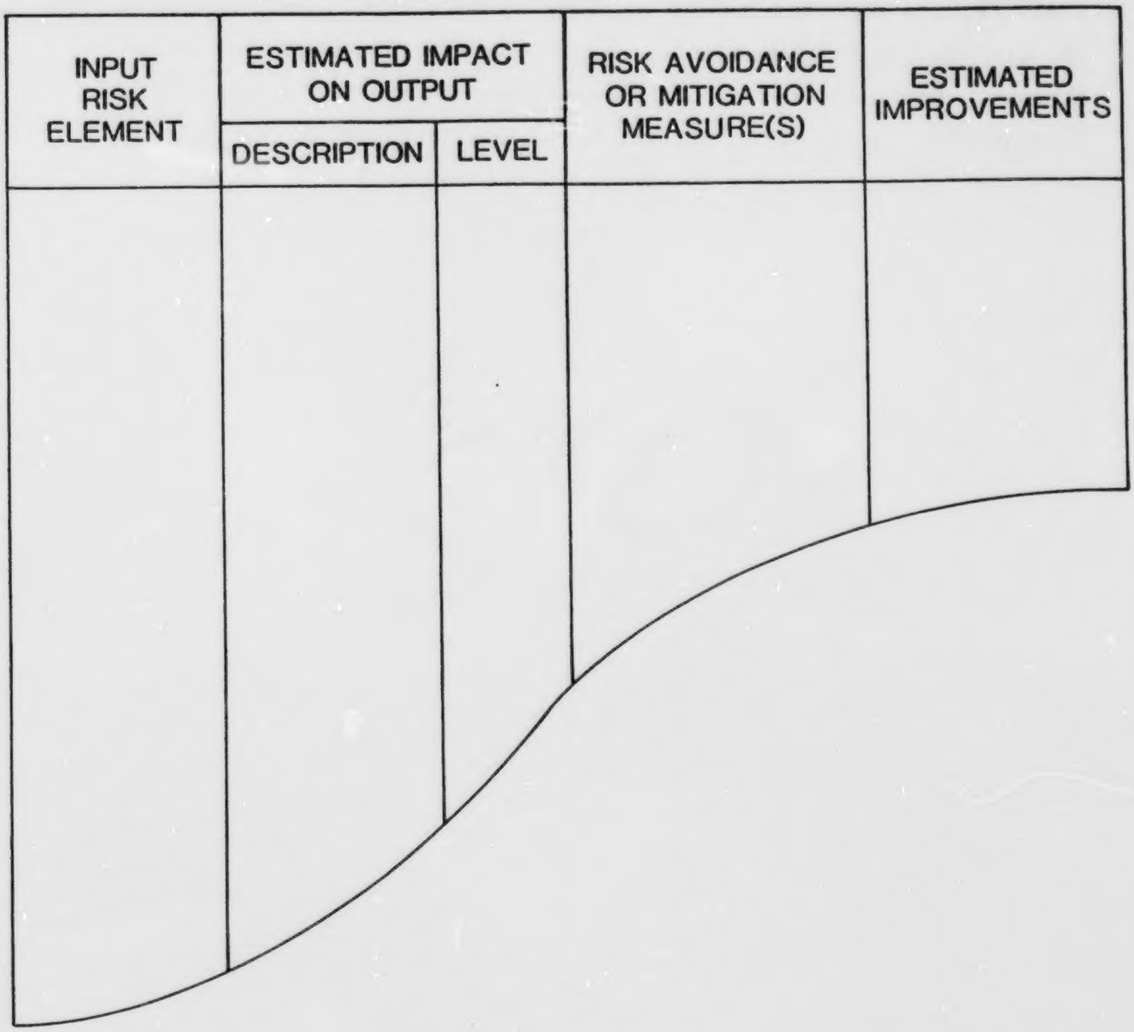
The decisionmaker's role is to determine, which, if any, of the avoidance/mitigation measures should be introduced. Such decisions are typically based on minimizing regret. i.e. measures are instituted so as to minimize the worst case outcome. Figure 2 shows a typical format for informal risk analysis.

5.1.2 Structured Approach

The structured approach to risk management involves the development of a formal model with specified inputs, statistical parameters defining these inputs, and a means for producing the related outputs. A variety of tools are used here, depending on the particular situation under consideration. For situations that crop up frequently, generalized models are available. Two areas where this occurs are cost-schedule analysis and cost benefit analysis.

TABLE 1: RANKING, RATING AND SCORING TECHNIQUES

<table>
<tr><th>OPERATIONS</th><th>METHOD</th></tr>
<tr><td>Ranking: preference ordering of a set of alternatives (establish a first, second, third, etc.)</td><td>Pairwise Comparison
<table>
<tr><th></th><th colspan="4">ALTERNATIVE</th></tr>
<tr><th></th><th>A</th><th>B</th><th>C</th><th>D</th></tr>
<tr><td>A</td><td></td><td>+</td><td>+</td><td>+</td></tr>
<tr><td>B</td><td>0</td><td></td><td>0</td><td>+</td></tr>
<tr><td>C</td><td>0</td><td>+</td><td></td><td>+</td></tr>
<tr><td>D</td><td>0</td><td>0</td><td>0</td><td></td></tr>
<tr><td>TOTAL</td><td>0</td><td>2</td><td>1</td><td>3</td></tr>
<tr><td>RANK</td><td>4</td><td>2</td><td>3</td><td>1</td></tr>
</table></td></tr>
<tr><td>Rating: establish, on a relative scale a preference measure among alternatives (i.e. A is 60% as attractive as B etc.).</td><td>Successive Ratings
<table>
<tr><td>Alternative</td><td>A
B
C
D</td><td>100
70
20
10</td><td>125
60
20
10</td><td>100
65
20
10</td></tr>
<tr><td></td><td></td><td>compared to most preferred</td><td>comp.to least pref.</td><td>comp. to most & least pref.</td></tr>
</table></td></tr>
<tr><td>Scoring: establish, on an absolute scale, a measure of the relative attractiveness of alternatives (i.e. A scores 65, B scores 32 etc.)</td><td>
<table>
<tr><th></th><th colspan="4">Alternatives</th></tr>
<tr><th></th><th>A</th><th>B</th><th>C</th><th>D</th></tr>
<tr><td>Performance (wt. 3.0)</td><td></td><td></td><td></td><td></td></tr>
<tr><td>handling</td><td>1</td><td>1</td><td>0</td><td>1</td></tr>
<tr><td>fuel economy</td><td>0</td><td>1</td><td>0</td><td>0</td></tr>
<tr><td>factor score</td><td>0.5</td><td>1.0</td><td>0</td><td>0.5</td></tr>
<tr><td>Reliability (wt. 2.0)</td><td></td><td></td><td></td><td></td></tr>
<tr><td>engine</td><td>1</td><td>1</td><td>1</td><td>0</td></tr>
<tr><td>drive train</td><td>1</td><td>0</td><td>0</td><td>1</td></tr>
<tr><td>factor score</td><td>1.0</td><td>0.5</td><td>0.5</td><td>0.5</td></tr>
<tr><td>Aesthetics (wt. 1.0)</td><td></td><td></td><td></td><td></td></tr>
<tr><td>exterior</td><td>0</td><td>1</td><td>0</td><td>1</td></tr>
<tr><td>interior</td><td>1</td><td>1</td><td>1</td><td>1</td></tr>
<tr><td>factor score</td><td>0.5</td><td>1.0</td><td>0.5</td><td>1.0</td></tr>
<tr><td>Weighted score</td><td>4.0</td><td>5.0</td><td>1.5</td><td>3.5</td></tr>
</table></td></tr>
</table>



INPUT RISK ELEMENT	ESTIMATED IMPACT ON OUTPUT		RISK AVOIDANCE OR MITIGATION MEASURE(S)	ESTIMATED IMPROVEMENTS
	DESCRIPTION	LEVEL		

FIGURE 2: INFORMAL RISK MANAGEMENT

Various general purpose benefit-cost packages are available that automatically combine time series of benefits and costs according to standardized instructions for discounting, identifying cost and benefit streams and indicators, as well as performing sensitivity analysis. Such tools require cost and benefit streams as data inputs, and simply perform the discounting and compilation of cost benefit indicators on these streams. One such tool is CBPACK developed by the World Bank. (This package also incorporates provision for conducting risk analysis and is proposed for that purpose elsewhere in the report.)

Volume

2

TP6069E

CANADIAN AIRSPACE SYSTEM

VOLUME II PROGRAM MANAGEMENT SYSTEM (SYSTEM DESCRIPTION)

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AND THE
TRANSPORTATION DEVELOPMENT CENTRE

SEPTEMBER 1985

The contents of this report reflect the views of the contractor and not necessarily the official views or policies of Transport Canada.

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17. Abstract

The Canadian Airspace System Plan (CASP) is a comprehensive plan for modernizing and improving the Canadian Airspace System. There are literally thousands of air traffic control and air navigation facilities comprising the Canadian Airspace System. Projects to modernize these facilities are in various stages of implementation. Implementation of some projects may dictate changes in, or alterations to, air traffic procedures, aircraft equipage, or flight procedures as well as impacting other projects. The Canadian Airspace Systems Engineering Plan describes a unique systems engineering based approach for organizing and managing the implementation of CASP.

Volume 1: Systems Engineering Management Implementation Plan: This report describes a series of systems engineering planning activities and processes; structures the many individual projects in the Canadian Airspace System Plan; describes a program management hierarchy; identifies tools available to support management; estimates the number of person-years of technical/engineering support required; mandates a series of specific actions required; and, reports progress on their implementation.

Volume 2: Program Management System (System Description);
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Volume 4: Level I System Design (to facility level);
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17. Abstract

Le Plan d'aménagement de l'espace aérien du Canada vise à moderniser l'organisation et la gestion de cet espace dont la surveillance fait appel à un nombre très élevé d'installations pour le contrôle de la circulation aérienne et la radionavigation. Ce Plan met en oeuvre un grand nombre d'actions ayant atteint un stade plus ou moins avancé et dont certaines implequent des modifications aux procédures de circulation aérienne ou de vol en vigueur, ou aux normes d'équipement des aéronefs. Pour la réalisation de ce Plan, une approche systémique est préconisée dans ce rapport.
Le rapport comporte cinq parties:
Volume 1: Systems Engineering Management Implementation Plan; ce rapport décrit ou définit: les actions à lancer et les procédés à appliquer en matière de planification; l'ordonnancement général des nombreux éléments du Plan; les liaisons hiérarchiques à établir; les services de soutien au programme de gestion; le tableau estimatif des effectifs techniques à prévoir; et enfin, les progrès accomplis.
Les autres parties traitent plus en details des sujets suivants:
Volume 2: Program Management System (System Description);
Volume 3: Identification and Consolidation of Hierarchy of Documentation;
Volume 4: Level I System Design (to facility level);
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PREFACE

CASP

The Canadian Airspace Systems Plan (CASP) is a comprehensive plan to modernize the national airspace systems for radar, navigation, communications, aviation weather, air navigation and other services and systems. The projects that make up CASP are in various stages of implementation; some systems are currently being implemented, some are being designed, some are being planned, and others are yet to be started. The Plan covers service improvements to the year 2000. All of the activities of CASP projects are related, and many projects are interrelated. To manage this interrelatedness it has been decided to "bundle" interdependent projects into a series of major projects. Examples of such major projects are radar modernization (RAMP), communication switch (MACS), and microwave landing system (MLS), nine other major projects have been defined.

CASP is not only concerned with the engineering development schedule, but also with the financial management and resource management aspects of the total program.

This manual contains information related to the general capabilities of the Canadian Airspace Systems Plan Program Management System (CASP/PMS). It also contains detailed descriptions of the processes and procedures that are necessary to utilize the capabilities of the system. It is intended as an introduction to CASP/PMS for the first time user, and also as a reference manual to provide specific information about each function in the system for the experienced user. This document describes the system and its use from this standpoint of program level users. Separate documentation will describe the system and its use for major project, project, subproject and contract level users. Each of these documents must be used in conjunction with other policy and reference manuals as follows: The Systems Engineering Management Implementation Plan for the Canadian Airspace System Chapter 3 (which should be read first) and the PROMIS or PMS II user manuals (which should be read last).

The CASP/PMS system description is divided into five Sections and eight Appendices, as follows:

Section 1:	**INTRODUCTION**	Describes the requirement to assist managers in planning and controlling large numbers of interdependent activities, and outlines the way in which this can be achieved using the Program Management System (PMS).
Section 2:	**OVERVIEW**	Provides an overview of the features of CASP/PMS; a description of the purpose and objectives of the system; an identification of the role and responsibilities of the users of the system; and a bibliography of the supporting reference material that defines the policy and procedures that may be applicable.

Section 3:	**PROGRAM MANAGEMENT SYSTEM**	Describe the CASP/PMS framework; provides a detailed description of the system strategy for the schedule, cost and resource components of the Program Level, Site Level and Major Project Level.
Section 4:	**AUTOMATED SUPPORT TOOLS**	Describes the microcomputer-based software tools that are used to support implementation of CASP/PMS;
Section 5:	**USING THE SYSTEM**	Describes the operational procedures for using the CASP Program Management System and its automated support tools.
Appendix A:	**PROGRAM NETWORK DESCRIPTION**	Contains the PROMIS-based network model description for the program level schedule definition of the RAMP and MACS projects. The second part of this Appendix contains the complementary site network model description for the national network, initially comprising Ottawa TCU. s
Appendix B:	**MACS MILESTONES**	Contains the MACS project milestone definition for the program level, site level schedule and site data. s
Appendix C:	**RAMP MILESTONES**	Contains the RAMP project milestone definition for the program level, site level schedule and site data.

Appendix D:	**MILESTONE DEFINITION forms**	Contains blank forms to be used by the Projects Office to define correlated milestones (based on the milestones defined in Appendices B and C).
Appendix E:	**SPREADSHEET TEMPLATES**	Contains spreadsheet templates for cost/resource data for the program and project levels.
Appendix F:	**TERMINOLOGY**	Provides a dictionary of the terms and terminology that are used in the subsequent sections of the manual. It is recommended this dictionary be read before proceeding with the remaining material.
Appendix G:	**DOCUMENTATION**	Provides a listing of other documents that relate to the CASP/PMS.
Appendix H:	**OUTPUT REPORTS**	Provides a sample set of output reports available from the PROMIS project management package.

1: INTRODUCTION

REQUIREMENT

Management of the Canadian Airspace Systems Plan Program will involve the planning, and control of a large number of interdependent activities. As a base for doing this, a formal planning and control system is required. Such a system:

- displays the timing and interrelationships of all planned activities,
- identifies activities whose completion is critical to timely completion of the project,
- allows progress to be recorded against the plan, and
- displays the plan progress, and plan changes in a clear, easy to follow manner.

The system must enables managers to assess overall progress, to anticipate delays, to trace the sources of delays; and to communicate more effectively both with one another and with contractors.

PURPOSE AND OBJECTIVES

The effective management and control of the scheduling, costing, and resourcing for the CASP program, its major projects, sub-projects etc. can only be served by an automated program management system.

This document describes the program management system which has been developed for a trial operation incorporating two major projects, RAMP and MACS and which brings these together into an overall program network. The trial system can readily be extended to include all of the other CASP major projects, projects, sub-projects and contracts.

The objectives of the CASP Program Management System (CASP/PMS) are:

- To provide senior management and the Program Office with the facilities and the information necessary to efficiently and effectively monitor, coordinate, and evaluate the progress of the CASP program.
- To provide project managers with the facilities to plan and direct the implementation of projects.
- To develop disciplines, controls and standards for project management which support effective communications between the program and its major projects.

SOLUTION

To meet these needs, a set of software packages and a network of micro-computers have been brought together and linked with the aid of specially written computer programs. Together, this assemblage of hardware, software and procedures governing their use, constitute the CASP Program Management System.

The system operates as a support tool, assisting managers of the CASP program at all levels. As such, procedures for utilizing the CASP Program Management Systems, have been tailored to blend with already accepted management procedures within CATA.

HIERARCHY

Figure 1 illustrates the hierarchy of schedules for the program, major projects, projects and subprojects/contracts. The degree of detail increases at lower levels in the hierarchy and schedules at each level are subnetworks of higher level activities.

At each level in the hierarchy, the manager responsible has at his disposal a computer based scheduling cost control and allocation system that controls all activities within his span of responsibility.

SCHEDULE PLANNING AND CONTROL

At each level, the schedule is the basis for planning, resourcing, progress recording and for making plan changes. Figure 2 depicts the flow of schedule progress and plan change information. Progress information flows upwards based on raw progress data fed in at the contractor/subproject level. This progress information serves to update each network in the hierarchy, and may in turn suggest the need for plan changes. Where a

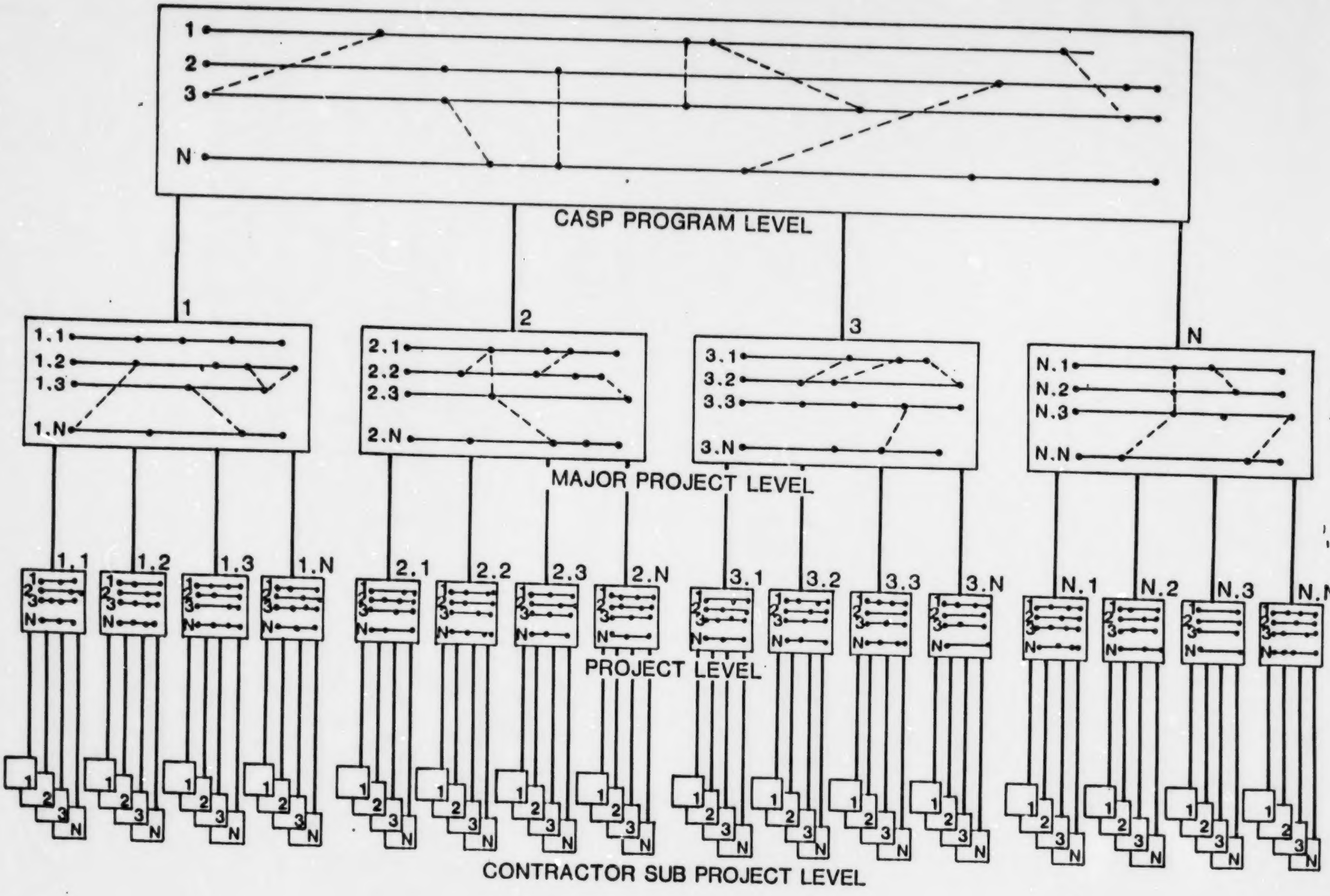
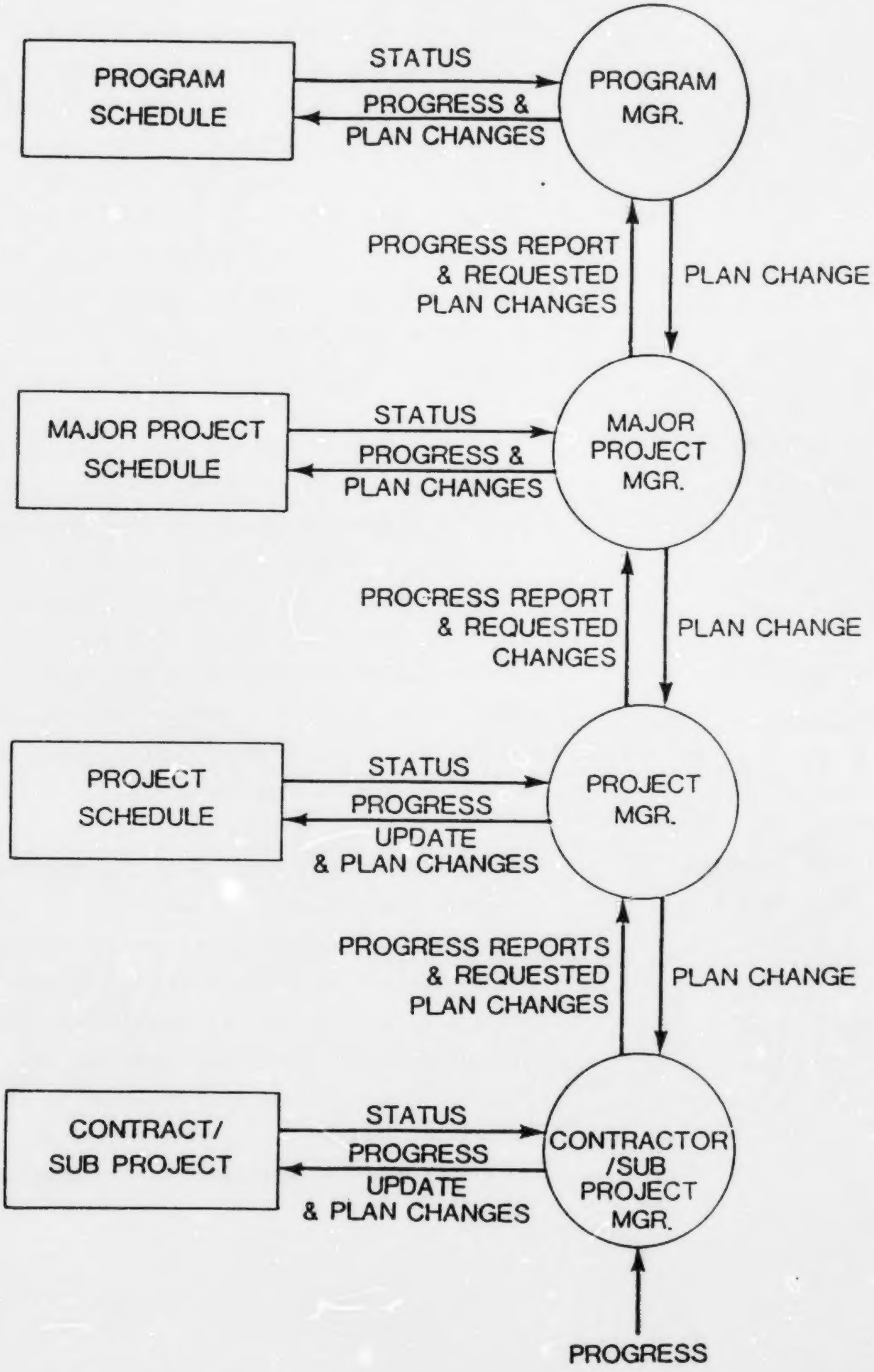

1
2
3
N
CASP PROGRAM LEVEL
1
2
3
N
1.1
1.2
1.3
1.N
2.1
2.2
2.3
2.N
3.1
3.2
3.3
3.N
N.1
N.2
N.3
N.N
MAJOR PROJECT LEVEL
PROJECT LEVEL
1
2
3
N
CONTRACTOR SUB PROJECT LEVEL

Figure 1: SCHEDULE STRUCTURE


PROGRAM SCHEDULE
STATUS
PROGRESS & PLAN CHANGES
PROGRAM MGR.
PROGRESS REPORT & REQUESTED PLAN CHANGES
PLAN CHANGE
MAJOR PROJECT SCHEDULE
STATUS
PROGRESS & PLAN CHANGES
MAJOR PROJECT MGR.
PROGRESS REPORT & REQUESTED CHANGES
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PLAN CHANGE
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STATUS
PROGRESS UPDATE & PLAN CHANGES
CONTRACTOR /SUB PROJECT MGR.
PROGRESS

Figure 2: FLOW OF PROGRESS AND PLAN CHANGE INFORMATION

plan change is required, this is first examined to determine its likely impact on other program activities. Where the impact is confined to activities within the span of control of the manager initiating the change request, the plan change can be introduced on the authority of that manager. Where other activities are likely to be effected, the change request is presented at the next level and so on.

COST PLANNING AND CONTROL

The flow of cost information follows closely the program/project structure shown in Figure 2. At each level, cost data is summarized for presentation at the next higher level. Also at each level, a review process analyses the implications of actual and forecast revisions in conjunction with schedule information. Significant changes in planned spending are submitted to higher levels for approval and directed changes flow downwards.

RESOURCE PLANNING AND CONTROL

Allocation data is handled in the same manner as cost information. At each level in the hierarchy, allocations and schedule change decisions are optimized based on the cost of delays versus the need to promote balanced resource usage. Where resources are shared by several components at a given level or where schedule changes effect another component, resource usage is optimized at the next level up.

The allocation process operates in either of two modes. First, it can adjust the schedule so that prescribed resource limitations are not exceeded while at the same time ensuring minimum time for the project. Second, it can adjust the schedule so that certain prescribed milestone dates are met while attempting to minimize resource peaks.

Application of the resource allocation component will result in a precise start date for every activity instead of an earliest start date for each activity as results from a critical path calculation.

Typically several resource types can be handled simultaneously by the optimizing algorithm.

SCOPE

At present the Program Management System applies only to the program overall and to RAMP and MACS major projects. The system will be extended to incorporate other CASP major projects in due course.

RESPONSIBILITIES

The Canadian Airspace Systems Plan is the basis for controlling all air navigation and air traffic control systems acquisitions under one master strategy. Director, Facility Engineering and Systems Development Branch is responsible for this endeavour.

PROGRAM OFFICE

The development, implementation and operation of the CASP Program Management System are being coordinated by Systems Engineering (FSD), on behalf of the Director (FESD). FSD is responsible for CASP/PMS related Procedures.FSD forms part of the Program Office.

Assistance is provided by the Program Office to each Major Project Office for the training required for the operation of CASP/PMS.

MAJOR PROJECT OFFICE

The operation of the automated facilities that complement CASP/PMS; the preparation of project specific input to the Program Office for CASP/PMS; and the use of CASP/PMS facilities to assist with other project management tasks are the sole responsibility of the Major Project Office.

FRAMEWORK

The CASP/PMS currently established as a pilot system to handle two major projects MACS and RAMP and one site (OTTAWA). The system will handle additional CASP major projects and sites as they emerge.

The Program Management System is not predicated on any particular approach to project management on the part of major project managers. The framework will accommodate most project management techniques Network programming procedures may be based on PERT or CPM concepts; networks may be defined by precedence or activity-on-arrow methods; analysis of the network may include resource levelling, or least costing methods.

The framework can be depicted, as in Figure 3, with three levels:

Program
Site
Major Projects

PROGRAM LEVEL FRAMEWORK

The Program Level maintains a macro information view of the entire CASP program by monitoring a prescribed set of milestones for each of the major projects (correlated milestones). The milestone information is provided to the Program Level from the Major Project Level. Typical examples of these milestones may include:

Project Strategic Plan Approval
Preliminary Specifications Approved
RFP Issued
RFP Closing

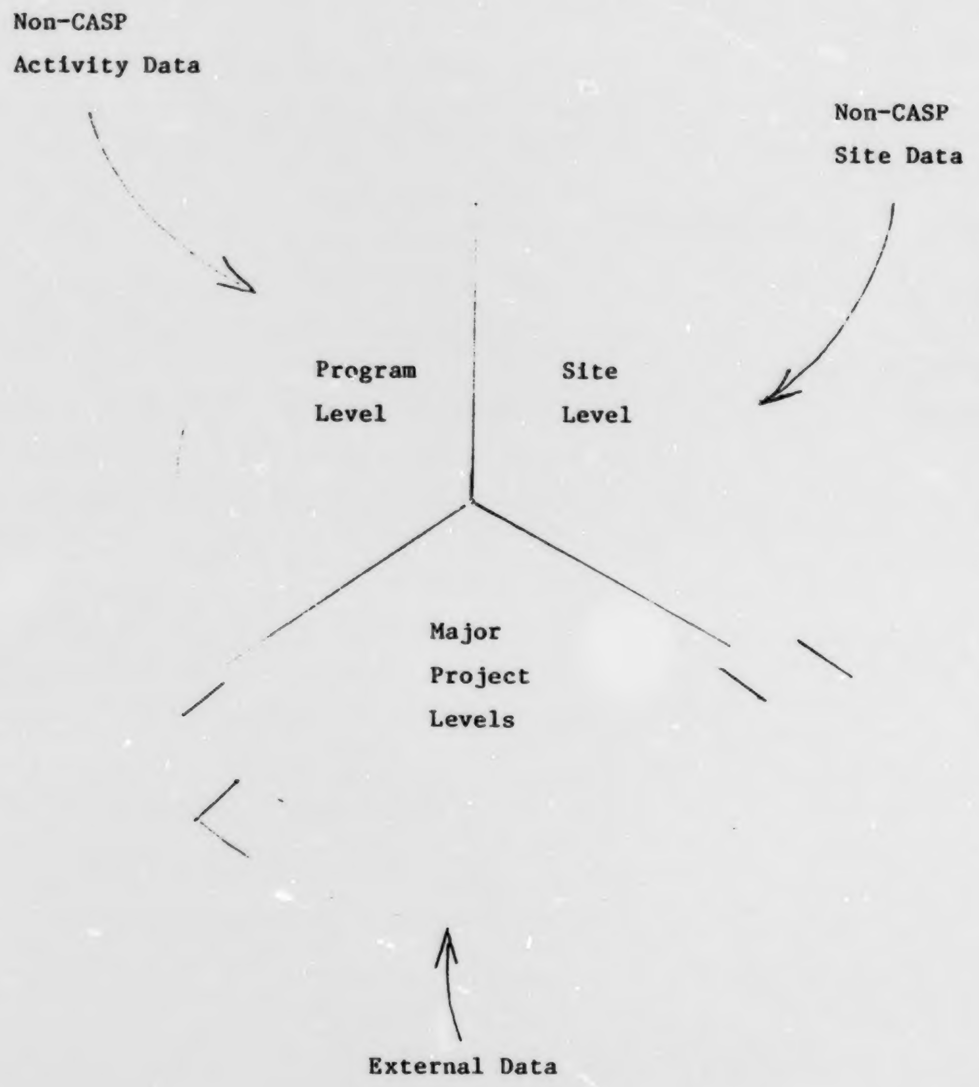

Non-CASP
Activity Data
Non-CASP
Site Data
Program
Level
Site
Level
Major
Project
Levels
External Data

Figure 3: PROGRAM MANAGEMENT SYSTEM FRAMEWORK

SITE LEVEL FRAMEWORK

The Site Level summarizes information at each site that is affected by site activities. This information is provided almost entirely from the Major Project Level although data may also originate from the Regions.

Typical examples of these milestones may include for each site and for each major project:

Site ready
Systems delivered
Spares delivered
Proof-of-performance completed

MAJOR PROJECT LEVEL FRAMEWORK

The Major Project Level maintains a detailed information view of all major project and project activities. This level monitors the details of any elements that may affect the major project or project cost, schedule, or resources. External information from non-CASP activities and from other CASP projects may also be reflected in this level.

For each level of this framework there are two associated Program Management System components:

Schedule
Cost & Resource

These level-component combinations are described in the following subsections:

PROGRAM LEVEL - SCHEDULE
PROGRAM LEVEL - COST & RESOURCE

SITE LEVEL - SCHEDULE
SITE LEVEL - COST & RESOURCE

MAJOR PROJECT LEVEL - SCHEDULE
MAJOR PROJECT LEVEL - COST& RESOURCE

PROGRAM-MAJOR PROJECT INTEGRATION

The CASP Program Management System described in the following sections of this document, defines the schedule, cost and resource integration functions between each of the following network pairs:

RAMP - CASP
MACS - CASP -
RAMP - MACS

and between these networks and sites. As other major projects and sites are added to the Program Management System hierarchy, these can easily be added the system.

The procedures described in this manual are primarily concerned with the CASP program level network and with the interfaces between the program level and major project levels. Not withstanding this, these procedures are equally applicable at the major project level to govern the flow of schedule, cost and resource data between the major project level and the project level.

External information from non-CASP activities may also be incorporated to the Program Level.

3: PROGRAM MANAGEMENT SYSTEM

INTRODUCTION

This section describes how schedule, cost and resource information is handled at the program level.

PROGRAM LEVEL SCHEDULE

The program level scheduling system provides an overview plan for major projects, together along with a means for registering progress against the plan.

The program level network summary milestones are those of the major project:

a) RAMP
b) MACS
c) (other major projects as they are integrated into the program management framework)

Key to the working of the program level schedule, is the linkage between it and the major projects.

This linkage of paramount importance without it there would be no effective integration of major project schedules with the program schedule. To ensure that all levels are maintained in constant harmony a scheme of linked milestones has been adopted.

PROGRAM LEVEL - CORRELATED MILESTONES

The milestone events that appear in the resultant network, a segment of which is depicted in Figure 4 (complete network in Appendix A), are common-sense progress monitoring points in each major project, and these milestones are defined by the Program Office in consultation with the Major Project Office. These milestones will subsequently be referred to as CORRELATED MILESTONES, because they are jointly defined in the program level network, as well as in the major project level network. Other milestones may also appear in the program or major project networks these however are not correlated milestones because the events are not part of both the program and the major project networks.

The use of correlated milestone permits the CASP program network to depict a synopsis of the project. In this manner the major project network can be modified as required (while retaining the correlated milestones) without affecting the CASP program network except when a change impacts on the timing of a correlated milestone.

Each major project is represented in the program network as a nominally defined set of correlated milestones (see Appendix B & C).

FIGURE 4

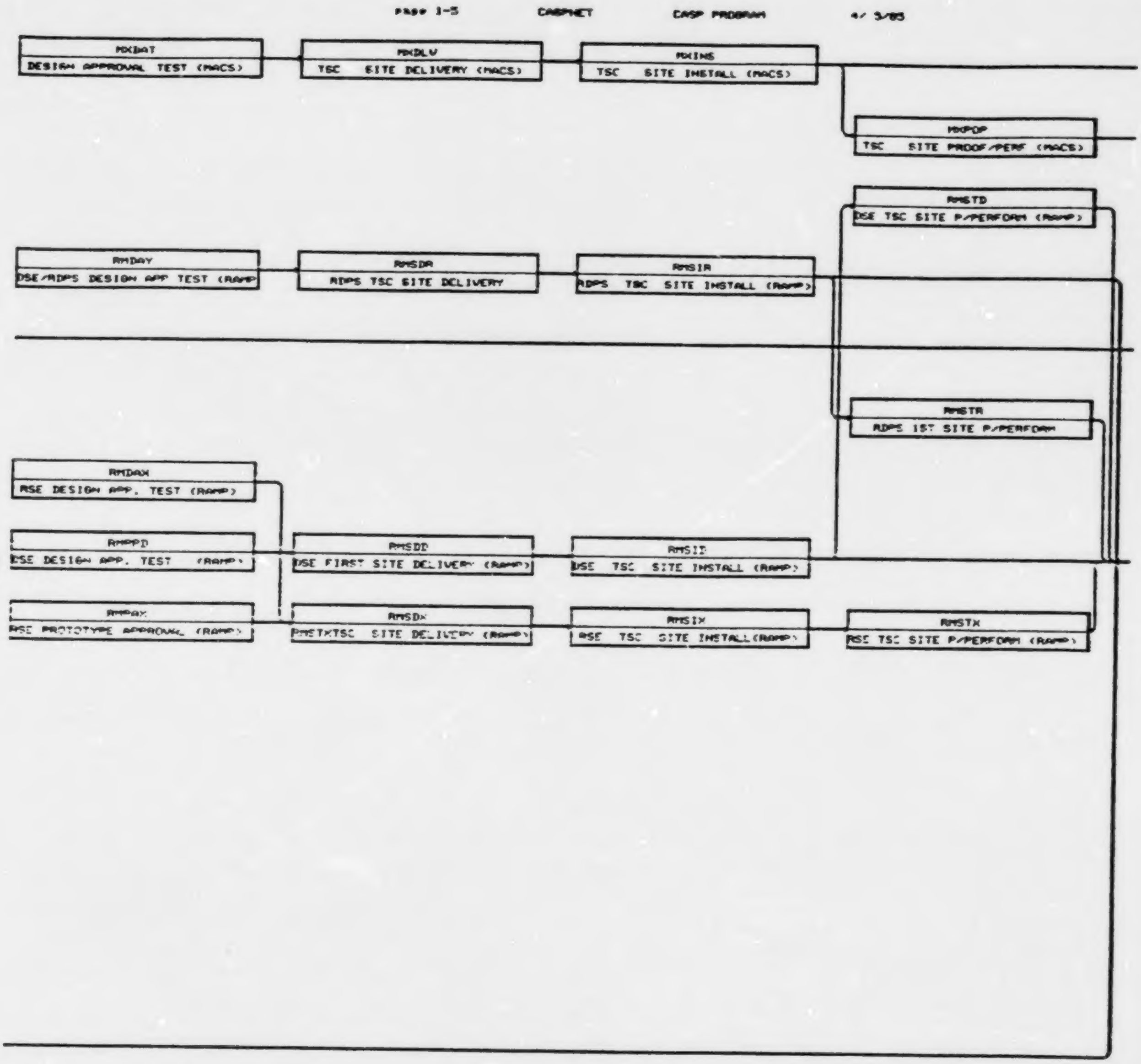

PAGE 1-5
CASPNET
CASP PROGRAM
4/ 3/85
MXDAT
DESIGN APPROVAL TEST (MACS)
MXDLV
TSC SITE DELIVERY (MACS)
MXINS
TSC SITE INSTALL (MACS)
MXPOP
TSC SITE PROOF/PERF (MACS)
RMSTD
DSE TSC SITE P/PERFORM (RAMP)
RMDAY
DSE/RDPS DESIGN APP TEST (RAMP
RMSDR
RDPS TSC SITE DELIVERY
RMSIR
RDPS TSC SITE INSTALL (RAMP)
RMSTR
RDPS 1ST SITE P/PERFORM
RMDAX
RSE DESIGN APP. TEST (RAMP)
RMPPD
DSE DESIGN APP. TEST (RAMP)
RMSDD
DSE FIRST SITE DELIVERY (RAMP)
RMSID
DSE TSC SITE INSTALL (RAMP)
RMPAX
RSE PROTOTYPE APPROVAL (RAMP)
RMSDX
RMSTXTSC SITE DELIVERY (RAMP)
RMSIX
RSE TSC SITE INSTALL(RAMP)
RMSTX
RSE TSC SITE P/PERFORM (RAMP)

Figure 4: PORTION OF PROGRAM NETWORK

A planned target date is normally established at the same time that the milestone is defined, but this date may be changed from time to time during the life of the major project.

Figure 5 illustrates an example of the linkage between the CASP program network and a typical major project. The correlated milestone A1 in the CASP network corresponds to the milestone A1 in the Major Project-"A" Network; the milestone A2 is similarly correlated. Milestone B1 in the CASP Program Network, corresponds to a correlated milestone B1 in the Major Project-"B" Network.

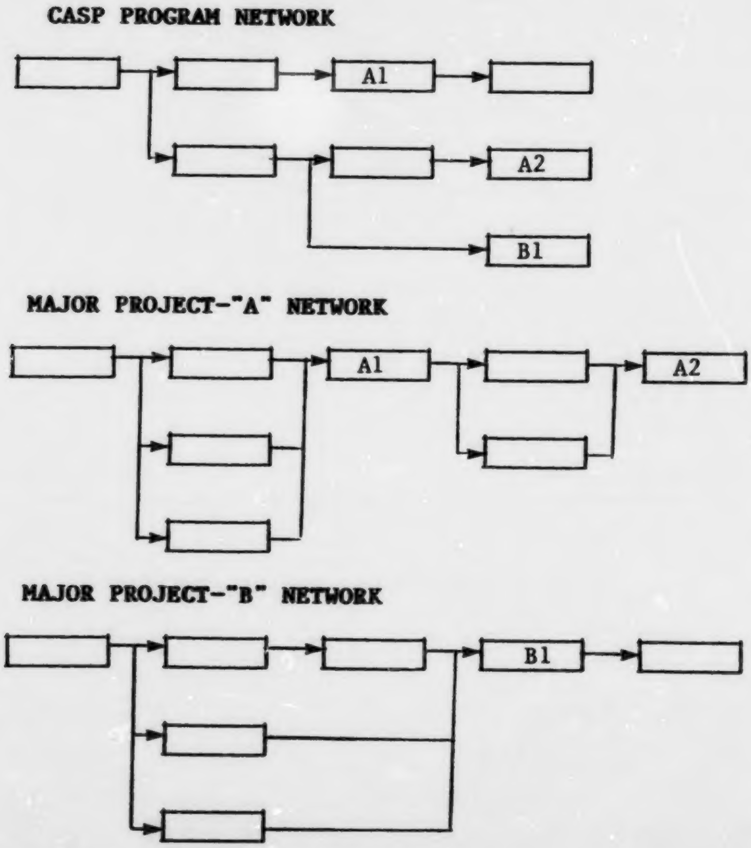

CASP PROGRAM NETWORK
A1
A2
B1
MAJOR PROJECT-"A" NETWORK
A1
A2
MAJOR PROJECT-"B" NETWORK
B1

FIGURE 5: PROGRAM-PROJECT LINKAGE

The planned date for a correlated milestone cannot be arbitrarily changed by either the Program Office or the concerned Major Project Office. It is highly probable that many other project schedules could be affected by a significant change in a correlated milestone planned date.

Therefore, each Project Office is committed to achieving their correlated milestone targets. If slippages or acceleration is evident, then the Major Project Office is responsible for informing the Program Office promptly. The Program Office in turn must liaise with the other Project Offices that will be affected by any changes to correlated milestone targets. If the Major Project Office fails to notify the Program Office of possible slippages and the slippage does actually occur, then the Program Office may only be able to determine this fact when normal monthly progress reporting to CASP/PMS is completed and the program network schedule has been analyzed. It may then be too late to undertake effective remedial action.

PROGRAM LEVEL - WORKBREAKDOWN STRUCTURE

The primary workbreakdown structure (WBS) at the CASP Program level is that of the major project:

a) RAMP
b) MACS
c) (other major projects as they are integrated into the program management framework)

The secondary WBS covers the first three phases of the typical life cycle of a project:

Identification
Planning
Implementation

The network model does not include operations (including maintenance) and disposal. The interested reader is directed to the Treasury Board, Administrative Policy Manual, Chapter 140 for additional guidelines in preparing a suitable WBS.

PROGRAM LEVEL COST SYSTEM

The Program level utilizes two systems for the analysis of cost information, in addition to the standard financial systems of CATA (Progis-Cap, CPRS, DRS). The first of these, the Network Cost System, is an integral part of the schedule system described in the previous section. As such, cost information must be broken down on a milestone basis. Since such breakdowns are not representative of current CATA cost control techniques, a second cost system based on a spreadsheet has also been developed. This system is similar to existing cost reporting systems within CATA, but is more responsive to project specific requirements.

The two cost systems will obtain cost information from the major project offices, the regions and the standard financial systems of CATA. The following sections describe these two systems.

NETWORK COST SYSTEM

Costs are assigned as lump sums to milestones.

Analysis of this cost information results in various cost summaries produced by sorting cost data according to - time period, cost type, responsibility, sub-project, user-defined code, etc.

Since the costs are assigned on a milestone basis, changes in the project network or schedule will be reflected in the pattern of costs incurred over time. This cost system is therefore an excellent tool for examining "what-if" scenarios. The timing and sequencing of projects can be altered in order to judge the effect on cost requirements for either individual projects or the CASP program as a whole.

Due to the difficulty in meaningfuly assigning cost information from a multitude of activities to a few milestones, rollups from the project to the program level cannot be performed using the network cost system and must be prepared manually by an analyst familiar with the CASP program.

SPREADSHEET COST SYSTEM

The Spreadsheet cost system has the advantages of extreme flexibility in what data is recorded, the form in which it is recorded, and the capabilities for analysis and summary. An example of a program level spreadsheet format is shown in Figure 6.

PROGRAM RESOURCE SYSTEM

An important resource to the project and program managers of the Canadain Airspace Systems Plan is manpower. Manpower is usualy expressed units of person years and catagorized by skills managers, technicians, analysts, support staff, etc.

FIGURE 6 A - COST WORKSHEET

PROGRAM

	CURRENT YEAR											
	ACTUAL					FORECAST						
	APR	MAY	JUN	JUL	AUG	SEPT	OCT	NOV	DEC	JAN	FEB	MAR
CAPITAL COSTS (MILLIONS OF DOLLARS)												
Mojor Project 1	19.0	52.0	52.0	41.0	39.0	37.0	88.0	65.0	19.0	22.0	80.0	81.0
Major Project 2	7.0	9.0	12.0	12.0	23.0	12.0	34.0	23.0	0.0	3.0	8.0	0.0
Major Project 3	9.0	3.0	6.0	6.0	4.0	3.0	9.0	8.0	6.0	7.0	5.0	3.0
Total Capital	35.0	64.0	70.0	59.0	66.0	52.0	131.0	96.0	25.0	32.0	93.0	84.0
OPERATING COSTS(MILLIONS OF DOLLARS)												
Mojor Project 1	0.06	0.15	0.24	0.33	0.42	0.51	0.60	0.69	0.78	0.87	0.96	1.05
Major Project 2	0.02	0.05	0.08	0.11	0.14	0.17	0.20	0.23	0.26	0.29	0.32	0.35
Major Project 3	0.03	0.06	0.09	0.12	0.15	0.18	0.21	0.24	0.27	0.30	0.33	0.36
Total Operating	0.11	0.26	0.41	0.56	0.71	0.86	1.01	1.16	1.31	1.46	1.61	1.76
TOTAL COSTS	35.1	64.3	70.4	59.6	66.7	52.9	132.0	97.2	26.3	33.5	94.6	85.8
RESOURCES (PERSON YEARS)												
Mojor Project 1	2.0	1.2	2.0	2.6	3.9	4.5	5.0	6.3	6.9	7.8	8.3	9.0
Major Project 2	0.1	0.1	0.3	0.5	0.7	0.9	1.1	1.3	1.5	1.7	1.9	2.1
Major Project 3	0.0	0.2	0.4	0.6	0.8	1.0	1.2	1.4	1.6	1.8	2.0	2.2
Total Resources	2.1	1.5	2.7	3.7	5.4	6.4	7.3	9.0	10.0	11.3	12.2	13.3
MACS												
A Total Capital	19.0	52.0	52.0	41.0	39.0	37.0	88.0	65.0	19.0	22.0	80.0	81.0
Total Operating	0.1	0.2	0.2	0.3	0.4	0.5	0.6	0.7	0.8	0.9	1.0	1.1
Total Resources	2.0	1.2	2.0	2.6	3.9	4.5	5.0	6.3	6.9	7.8	8.3	9.0

	CURRENT YE					MULTI-YEAR							PREVIOUS	FUTURE	TOTAL
						ACTUAL		FORECAST							
	FORECAST	BUDGET	COMMITED	EXPENDED	VALUE COMPLETED	83/84	84/85	85/86	86/87	87/88	88/89	89/90	YEARS EXPENDED	YEARS FORECAST	ESTIMATED COST
CAPITAL COSTS (MILLIONS OF DOLLARS)															
Mojor Project 1	595.0	458.0	350.0	220.0	260.0	34.0	165.0	595.0	813.0	594.0	404.0	198.0	199.0	2009.0	2803.0
Major Project 2	143.0	133.0	120.0	120.0	110.0	0.0	45.0	143.0	100.0	200.0	137.0	0.0	45.0	437.0	625.0
Major Project 3	69.0	60.0	0.0	0.0	0.0	0.0	0.0	69.0	23.0	54.0	67.0	78.0	0.0	222.0	291.0
Total Capital	807.0	651.0	470.0	340.0	370.0	34.0	210.0	807.0	936.0	848.0	608.0	276.0	244.0	2668.0	3719.0
OPERATING COSTS(MILLIONS OF DOLLARS)															
Mojor Project 1	6.66	6.30	3.00	1.50	1.10	4.50	9.00	6.66	2.25	4.50	6.75	9.00	13.50	22.50	42.66
Major Project 2	2.2	2.0	1.0	0.7	0.5	1.50	3.00	2.22	0.75	1.50	2.25	3.00	4.5	7.5	14.2
Major Project 3	2.3	2.3	1.0	0.0	0.0	2.00	3.50	2.34	1.00	1.75	2.50	3.25	5.5	8.5	16.3
Total Operating	11.2	10.6	5.0	2.2	1.6	8.00	15.50	11.22	4.00	7.75	11.50	15.25	23.5	38.5	73.2
TOTAL COSTS	818.2	661.6	475.0	342.2	371.6	42.0	225.5	818.2	940.0	855.8	619.5	291.3	267.5	2706.5	3792.2
RESOURCES (PERSON YEARS)															
Mojor Project 1	59.5	57.5	115.8	171.3	284.5	10.0	19.0	59.5	10.0	22.5	35.0	47.5	29.0	115.0	203.5
Major Project 2	12.2	11.0	10.0	5.0	6.0	1.0	3.0	12.2	1.5	4.0	6.5	9.0	4.0	21.0	37.2
Major Project 3	12.7	11.0	9.0	3.0	6.0	1.5	3.5	12.7	2.0	4.5	7.0	9.5	5.0	23.0	40.7
Total Resources	84.4	82.3	165.2	244.8	406.3	12.5	25.5	84.4	13.5	31.0	48.5	66.0	38.0	159.0	281.4
MACS															
A Total Capital	595.0	458.0	350.0	220.0	260.0	34.0	165.0	595.0	813.0	594.0	404.0	198.0	199.0	2009.0	2803.0
Total Operating	6.7	6.3	3.0	1.5	1.1	4.5	9.0	6.7	2.3	4.5	6.8	9.0	13.5	22.5	42.7
Total Resources	59.5	57.5	115.8	171.3	284.5	10.0	19.0	59.5	10.0	22.5	35.0	47.5	29.0	115.0	203.5

Conceptually there is little difference between costs and resources, i.e. money is a resource as essential as manpower to the success of a project.

Because of the similarities between costs and resources, they are treated in identical fashion either using a spreadsheet or using the network resource system.

SITE LEVEL - SCHEDULE SYSTEM

The site level system is aimed at providing an overview of scheduled activities at sites and as a basis for registering progress at sites. The program site level network contains activity data for all major projects at each CASP site.

For each site, major project activity typically covers logical stages of the implementation life cycle, namely:

site preparation
system delivery
system installation
proof of performance
spares delivery
training
integration test
operational readiness demo
site commisioned

These activities are handled as CORRELATED MILESTONES in the same way as previously described in the discussion of the program level schedule network.

This program site level network defines the site interrelationships on a project-by-project basis (see Figure). Note that it is not possible to produce a National Site Network precedence summary such as, "Site A, Site B, Site C..." because this definition would be incompatible for some major project which for example could have the precedence "Site A, Site C, Site B".

The site level network which is maintained by the CASP Program Office with data provided by the Project Offices is distinct from the program level network (Figure 3). This was done in order to minimize the total amount of information that is present in any one network model for convenience.

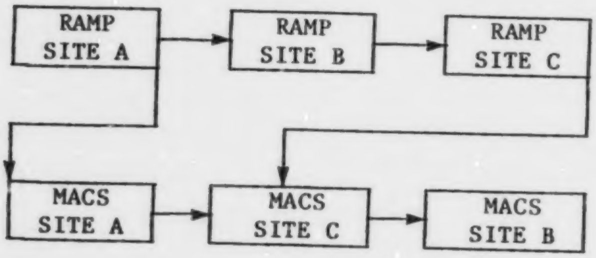


FIGURE 6B: SITE NETWORK

SITE LEVEL - COST & RESOURCES

Monitoring of cost and resources at the site level is performed in an identical fashion to that for the program level schedule. In summary, there are two systems. The first, the network system, uses the schedule network to maintain a by-milestone breakdown of financial and resource requirements. Roll-ups are not performed in this system. The second, the spreadsheet system, has a user defined spreadsheet which stores cost and resource information. This spreadsheet is of a structure similar to that defined in Figure 6 for the program level. However appropriate heading substitutions are required for site data. Roll-ups from level to level can be performed. Both of these systems have extensive data analysis and information reporting capabilities.

The spreadsheet cost system can be used as central registry for cost information from the various CATA financial systems. This means, for example, that cost information for the current year, past years, and future years can be stored in one location. Comparisons and analysis of actual and forecasted costs are easily obtained. The analysis may take advantage of the extensive graphical, numeric and statistical capabilities of the spreadsheet package.

With the assistance of the project offices, the spreadsheet cost system can be used to transmit cost information summaries from the project to the program levels. These summaries can be tailored to any detail or form desired - with the possibility of significantly improving upon the utility of cost information in comparison with that available from current CATA financial systems.

In addition to presenting costs in the traditional functional categories, the spreadsheet cost system displays cost information by activity - similar to the network cost system. Using the programming capabilities of the spread sheet package, "what-if" scenarios can be examined quickly.

4: AUTOMATED SUPPORT TOOLS

INTRODUCTION

The magnitude of the CASP program with many major projects, hundreds of site installations and thousands of activities demand the use of some automated facilities. CASP/PMS has been designed to be implemented on a group of personal computers that are readily accessible by CASP managers. The CASP/PMS system consists of a set of software packages together with a custom program.

The software packages that are currently utilized consist of two project management systems and a spreadsheet system.

This CASP Program Management Reference Manual does not present user information on the program tools. (These facilities are documented in their corresponding reference manuals.)Rather it describes the overall system in which these tools are embedded and provides the information necessary to make the various tools operate together.

Accordingly, the following paragraphs outline key features of:

- The basic project management packages (PROMS and PMS II)
- LOTUS 1-2-3/Symphony

PROMIS, PMS-II

The CASP Program Management System utilizes two project management microcomputer packages:

PROMIS - Project Management Integrated System

PMS-II - Project Management System II

These packages are used to prepare the network schedules for the program, site and major project sectors of CASP/PMS. They also provide the schedule analysis facilities to determine the feasibility of planned schedules. In addition the project management systems support the basic resource analysis services that are required for CASP/PMS. Although the packages are not primarily concerned with the handling of cost analysis, they are used for answering fundamental "what if?" functions for some cost planning exercises.

A wide variety of output reports are available from PROMIS and PMS II. These are selectable by the user and are described in the PROMIS and PMS II package documentation. Appendix H contains a sample set of PROMIS output reports.

Pilot networks for the program and site are currently implemented in PROMIS (Appendix A). In addition the MACS project is also implemented in PROMIS. The RAMP project is implemented in PMS-II. Additional projects can be integrated into the CASP Program Management System.

i) Easily if they use PROMIS or PMS-II

ii) With varying degrees of difficulty if they use any other system (Visischedule, Harvard Project Manager, Primavera Project Planner ...)

DEFINING THE NETWORKS

The CASP/PMS pilot system is supplied with a program level network in which the correlated milestones for the RAMP and MACS projects have already been defined (Appendix A).

The RAMP and MACS major project offices are responsible for the definition of their own networks.

With the introduction of new projects it will be necessary to add to the program level network definition. The existing network segments for RAMP and/or MACS may be used as a prototype for the new project, but the final definition will depend on the discussions that arrive at the definitive CORRELATED MILESTONES for the program and site networks (Appendix C), and on the interrelationships, if any, between the new project and the existing projects (RAMP, MACS).

NAMING CORRELATED MILESTONES - PROGRAM LEVEL

Program level milestones which have correlated major project/project/sub-project milestones have a definitive naming structure:

MXaa For all MACS tasks
RMbbb For all RAMP tasks
Where aaa, and bbb are arbitrarily defined 3-character codes unique for each milestone.
Thus, for example RAMP - is the APD approved milestone for RAMP.
MXAPD - is the APD approved milestone for MACS.
MXSPE - is the final specifications approved milestone for MACS.
RMSPD - is the final specifications approved milestone for RAMP (DSE).

Other projects to be added to the program network, will have a similar naming structure, for example:

MLccc - Microwave Loading System
FSccc - Flight Service Station Modernization
FDccc - Flight Data Processing Modernization
CPccc - Control and Performance Monitoring System
AIccc - Aeronautical Information Processing System

For those major projects that utilize the PROMIS project management package, the correlated milestones in their network should be named identically, however this is not absolutely necessary. If the milestone names are not identical then the project manager must prepare a list of equivalences; for example with MACS

PROGRAM MILESTONE NAMES	PROJECT MILESTONE NAMES
MXAOK	ABCDE
MXOFF	FGHIJ
MXetc	ETC

(These names are only examples and any resemblance to actual names is coincidental)

For projects that utilize the PMS-II a similar equivalence table must be prepared.

PROGRAM MILESTONE NAMES	PROJECT MILESTONE SNODE - ENODE
RMAOK	104 - 114
RMOFF	116 - 126
RMetc	99 - 999

(These nodes are only examples, and any resemblance to actual values is coincidental)

The SNODE - ENODE must correspond to a real activity and not a dummy.

The milestone equivalences defined are reported in the PROGRAM MILESTONE DICTIONARY forms provided in Appendix E.

CORRELATED MILESTONES - SITE LEVEL

It is also necessary for project managers of major projects, projects and sub-projects to prepare a list of milestone name equivalence for the site level.

The process is similar to that for the program/project equivalences with the added requirement that the site location must also be specified. Thus for example in a PROMIS - PROMIS network the equivalences would be defined as follows:

SITE MILESTONE NAMES (PROGRAM)	LOCATION	SITE MILESTONE NAMES (PROJECT)
MXSPR	ZM	VWXYZ
MXect	MX	ETC

(These tags are only examples, and any resemblance to actual values is entirely coincidental).

Note that in this contrived example MX is a location identifier (Mirabel) as well as a project identifier.

For a PMS-II based network the equivalences would be defined as follows:

SITE MILESTONE NAMES (PROGRAM)	LOCATION	SITE MILESTONE SNODE-ENODES
RMDEL	ZD	1015-1016
RMRDY	DW	2090-2095

(Again, the tags are only examples, the equivalence may be meaningless).

The milestone equivalences are reported on the SITE MILESTONE DICTIONARY forms provided in Appendix E.

The extensive number of sites makes it impractical to attempt to prepare a list of unique milestone names for all sites. Therefore a general site network template has been defined (Appendix G). A customized version of this network can be prepared for each site as appropriate. The combination of a two-letter location identifier (selected from the Canadian Loction Identifiers directory) together with a generic milestone name from the network template will uniquely tag the milestone for the site level network.

SCHEDULE ROLL-UP

A custom ROLLUP program is used to transfer correlated milestone information for

ACTUAL START
ACTUAL FINISH

between the project level and the program level.

ROLLUP handles both program and site network data for projects that utilize either the PMS-II or PROMIS project management systems.

Additional details pertaining to the operation of ROLLUP are provided in Section 5.

1-2-3, SYMPHONY

PROMIS and PMS-II provide extensive facilities for handling project and program cost and resource data elements. However, these data are required on an activity level basis, and normally they are available only on an aggregate basis.

1-2-3 spreadsheet templates have been developed to accomodate program and project data. The cost and resource spreadsheet templates complement the facilities available in PROMIS and PMS-II.

COST AND RESOURCE ROLL-UP

Roll-up of cost and resource information from the major project to the program level requires a minimum amount of effort on the part of managers at each level using the 1-2-3 spread-sheet system.

The following sub-sections describe how such spread-sheets and roll-ups are developed and outline the use of the CASP/PMS pilot system spread-sheets.

One of the greatest advantages of this system is its extreme flexibility. The user may make modifications to suit the system to his own needs. Such modifications will require some knowledge of Lotus 1-2-3 or Symphony on the part of the user. The user is referred to the 1-2-3/Symphony manuals for specific technical information.

DEVELOPMENT OF A SPREAD-SHEET ROLL-UP SYSTEM

The actual form and content of spread-sheets at the major project and program levels is of concern only to each individual manager. However, when data transfer between spread-sheets is desired there must also be agreement on form and content between managers. Therefore, the first step is for the major project and program offices to negotiate exactly the form and content of the data to be rolled-up. Typically this will be some condensed and summarized version of the data which the Major Project maintains in a spread-sheet for its own purpose.

The Major Project Office then assigns a 1-2-3 named region to an area of its spread-sheet for the data which is to be rolled-up. The project names this region with a previously agreed upon name (such as ROLLUP) using the named region capability of 1-2-3/Symphony (/WRN /Worksheet Range Name). The Major Project Office then simply gives a copy of the updated worksheet, on a diskette, to the Program Office at regular intervals.

The Program Office, in the mean time, has developed its own spread-sheet into which it wishes to transfer data from each Major Project Office. Ideally, the named region into which the Program Office will transfer the data has been correlated with the major project spread-sheet so that the appropriate cells will be automatically updated by the new data. The Program Office uses the file import capability of Symphony (the program office must use Symphony and not 1-2-3) to transfer the named region from the Major Project diskette to their own spread-sheet.

5: USING THE SYSTEM

INTRODUCTION

The integration of the CASP Project Management System is based on the ability to "roll-up" information summaries from lower to higher levels in the program management hierarchy. The two CASP/PMS components which have been developed, network and spreadsheet, have this capability. The network system is used to roll-up schedule information, and the spread-sheet system is used to roll-up cost and resource information. The following two sections describe how to use these capabilities within each system.

USE OF PRE-DEFINED SPREADSHEETS MAJOR PROJECT OFFICE

Figure 7 presents a 1-2-3 (Symphony) spreadsheet for use by the Major Project Offices. Information concerning Capital costs, operating costs and resources (headings down the left side of the spreadsheet) is maintained for the current and future years (headings along the top of the spreadsheet).

Initially the Major Project Office collects information from various sources with which to fill in the appropriate spreadsheet cells. Data is entered by simply moving the cursor to the appropriate position, typing the data, and then pressing return. Many cells are preformatted to automatically perform calculations such as aggregations using data in other cells.

Information in the spreadsheet is updated by entering the new data in a manner identical to the way it was entered in the first place.

FIGURE 7. COST WORKSHEET

MAJOR PROJECT 1

	CURRENT YEAR													
	ACTUAL					FORECAST								
	APR	MAY	JUN	JUL	AUG	SEPT	OCT	NOV	DEC	JAN	FEB	MAR	FORECAST	BUDGE
CAPITAL COSTS (MILLIONS OF DOLLARS)														
Contract 1	4.0	40.0	34.0	23.0	12.0	22.0	45.0	34.0	13.0	12.0	67.0	78.0	384.0	265.
Contract 2	6.0	9.0	12.0	12.0	23.0	12.0	34.0	23.0	0.0	3.0	8.0	0.0	142.0	133.
Contract 3	9.0	3.0	6.0	6.0	4.0	3.0	9.0	8.0	6.0	7.0	5.0	3.0	69.0	60.
Total Capital	19.0	52.0	52.0	41.0	39.0	37.0	88.0	65.0	19.0	22.0	80.0	81.0	595.0	458.
CUMM. CAPITAL	19.0	71.0	123.0	164.0	203.0	240.0	328.0	393.0	412.0	434.0	514.0	595.0		
OPERATING COSTS (MILLIONS OF DOLLARS)														
Overtime	0.01	0.04	0.07	0.10	0.13	0.16	0.19	0.22	0.25	0.28	0.31	0.34	2.1	2.
Travel	0.02	0.05	0.08	0.11	0.14	0.17	0.20	0.23	0.26	0.29	0.32	0.35	2.2	2.
Miscellaneous	0.03	0.06	0.09	0.12	0.15	0.18	0.21	0.24	0.27	0.30	0.33	0.36	2.3	2.
Total Operating	0.06	0.15	0.24	0.33	0.42	0.51	0.60	0.69	0.78	0.87	0.96	1.05	6.7	6.
TOTAL COSTS	19.1	52.2	52.2	41.3	39.4	37.5	88.6	65.7	19.8	22.9	81.0	82.1	601.7	464.
RESOURCES (PERSON YEARS)														
Managers	3.0	0.5	0.5	0.3	0.8	0.6	0.3	0.8	0.6	0.7	0.4	0.3	8.8	4.
Engineers	1.5	0.1	0.3	0.5	0.7	0.9	1.1	1.3	1.5	1.7	1.9	2.1	13.6	11.
Technicians	0.0	0.2	0.4	0.6	0.8	1.0	1.2	1.4	1.6	1.8	2.0	2.2	12.7	11.
System Analysts	0.0	0.2	0.4	0.6	0.8	1.0	1.2	1.4	1.6	1.8	2.0	2.2	13.2	12.
Support Staff	0.4	0.3	0.5	0.7	0.9	1.1	1.3	1.5	1.7	1.9	2.1	2.3	14.2	12.
Total Resources	4.9	1.2	2.0	2.6	3.9	4.5	5.0	6.3	6.9	7.8	8.3	9.0	62.4	57.

A

MACS														
Total Capital	19.0	52.0	52.0	41.0	39.0	37.0	88.0	65.0	19.0	22.0	80.0	81.0	595.0	458.
Total Operating	0.1	0.2	0.2	0.3	0.4	0.5	0.6	0.7	0.8	0.9	1.0	1.1	6.7	6.
Total Resources	4.9	1.2	2.0	2.6	3.9	4.5	5.0	6.3	6.9	7.8	8.3	9.0	62.4	57.

```
CURRENT YEAR--------   ----------      -----------MULTI-YEAR -----------------    PREVIOUS    FUTURE      TOTAL
                                       ACTUAL------      ------FORECAST---------
 COMMITED  EXPENDED         VALUE      83/84 84/85 85/86 86/87 87/88 88/89 89/90      YEARS     YEARS ESTIMATED
                        COMPLETED                                                  EXPENDED  FORECAST      COST

    230.0     100.0         150.0       34.0 120.0 384.0 450.0 340.0 200.0 120.0      154.0    1110.0    1648.0
    120.0     120.0         110.0        0.0  45.0 142.0 340.0 200.0 137.0   0.0       45.0     677.0     864.0
      0.0       0.0           0.0        0.0   0.0  69.0  23.0  54.0  67.0  78.0        0.0     222.0     291.0
--------------------   ----------      -----------------------------------------   ------------------------------
    350.0     220.0         260.0       34.0 165.0 595.0 813.0 594.0 404.0 198.0      199.0    2009.0    2803.0
--------------------   ----------      -----------------------------------------   ------------------------------


      1.0       0.8           0.6       1.00  2.50  2.10  0.50  1.25  2.00  2.75        3.5       6.5      12.1
      1.0       0.7           0.5       1.50  3.00  2.22  0.75  1.50  2.25  3.00        4.5       7.5      14.2
      1.0       0.0           0.0       2.00  3.50  2.34  1.00  1.75  2.50  3.25        5.5       8.5      16.3
--------------------   ----------      -----------------------------------------   ------------------------------
      3.0       1.5           1.1       4.50  9.00  6.66  2.25  4.50  6.75  9.00       13.5      22.5      42.7
--------------------   ----------      -----------------------------------------   ------------------------------
    353.0     221.5         261.1       38.5 174.0 601.7 815.3 598.5 410.8 207.0      212.5    2031.5    2845.7
====================   ==========      =========================================   ==============================

      3.0       2.0           3.0        3.0   4.0   8.8   1.0   3.5   6.0   8.5        7.0      19.0      34.8
     10.0       5.0           6.0        1.0   3.0  13.6   1.5   4.0   6.5   9.0        4.0      21.0      38.6
      9.0       3.0           6.0        1.5   3.5  12.7   2.0   4.5   7.0   9.5        5.0      23.0      40.7
     11.0       8.0           3.0        2.0   4.0  13.2   2.5   5.0   7.5  10.0        6.0      25.0      44.2
      7.0       4.0           2.0        2.5   4.5  14.2   3.0   5.5   8.0  10.5        7.0      27.0      48.2
--------------------   ----------      -----------------------------------------   ------------------------------
    118.7     174.2         290.3       10.0  19.0  62.4  10.0  22.5  35.0  47.5       29.0     115.0     206.4
====================   ==========      =========================================   ==============================

---------------------------------------------------------------------------------------------------------------+
                                                                                                               |
    350.0     220.0         260.0       34.0 165.0 595.0 813.0 594.0 404.0 198.0      199.0    2009.0    2803.0  |
      3.0       1.5           1.1        4.5   9.0   6.7   2.3   4.5   6.8   9.0       13.5      22.5      42.7  |
    118.7     174.2         290.3       10.0  19.0  62.4  10.0  22.5  35.0  47.5       29.0     115.0     206.4  |
                                                                                                               |
---------------------------------------------------------------------------------------------------------------+
```

PROGRAM PROMPTS

The ROLLUP program is executed by entering the command "ROLLUP".

The next two user inputs (Figure 9) identify the project, and type of rollup required (General Summary, Site Summary). The following input defines the file name of the project DIF (or SDF) file. No further inputs are required until the rollup process is completed. At this point a query appears requesting authority to swap the old and new program level activity files; the normal response is "Y".

The ROLLUP program then recycles to permit another rollup to be performed. Multiple repeated executions are possible only when the swap authorization is "Y". If "N" is entered then in effect the CASPPROG.OLD and CASPSITE.OLD files are not replaced by their "XXXXXXXX.NEW" counterparts.

ROLLUP MESSAGES

The ROLLUP program creates an on-screen display file of the rollup progress. A typical output is illustrated in Figure 10. Reports can be generated by simply printing the whole spreadsheet or by specifying portions of it. The user should also be aware of the graphical and statistical capabilities of Symphony/1-2-3 described in the user manual.

Information requested by the Program Office is contained in the area marked "A" in Figure . This information is automatically updated from cells in the spreadsheet. No effort is required by the Major Project Office. At regular reporting intervals the Major Project Office makes a copy of their spreadsheet, and then gives it to the Program Office.

USE OF PRE-DEFINED SPREADSHEETS PROGRAM OFFICE

Figure 6 presents a Symphony spreadsheet for use by the Program Office. Summarizes information concerning the capital costs, operating costs and resources of the Major Projects (headings down the left side of the spreadsheet) is maintained for the current and future years (headings along the top of the spreadsheet).

Information is entered and updated by data transfer from Major Project spreadsheets the diskette containing a copy of the Major project spreadsheet is placed in drive A. If the Major Project Office is using Lotus 1-2-3, the extension name of the worksheet must be changed from WRK to WKS (in DOS: Rename XXXXXXXX.WRK XXXXXXXX.WKS). Enter Symphony Symphony), retrieve the Program spread-sheet, position the Cursor on the name of the Major Project under the spreadsheet (area "A" in Figure 6). Press the User funcion key then F1. Select the appropriate file name when prompted. The Program spreadsheet will then be automatically updated from information in the Major Project Spreadsheet.

USE OF PRE-DEFINED WORKSHEETS SUMMARY

Major Project Office

1. Up-date main spread-sheet
2. Provide a copy of the spread-sheet to the Program Office

Program Office

1. Enter Program spread-sheet
2. Place Major Project spread-sheet diskette in drive A;
3. position the cursor on the name of the major project, in the region for bringing in data, below the program spread-sheet
4. Press the user function key and then F1
5. Select the appropriate file name

NOTE: If the major project office is using Lotus 1-2-3, the work-sheet file name must be changed from XXXXXXXX.WRK to XXXXXXXX.WKS within DOS before the roll-up is performed.

ROLLUP

A ROLLUP facility is incorporated into CASP/PMS for the purpose of migrating information from the lower levels of the program management hierarchy to the management hierarchy to the program level for schedule data only.

The program level maintains two schedule summary networks:

General Summary Network
Site Summary Network

Schedule information in normally provided from the major project level, but information based on correlated milestones may be accessed from any level.

This ROLLUP program uses data files that must be specifically created from the PROMIS or PMS-II project management tools used at the major project or other levels.

ROLLUP DATA FILES

This section describes the ROLLUP program in terms of the files that it uses. Figure is a representation of this file structure.

DIF, SDF

When schedule progress is to be reported to the CASP Program Office, the major project or other level must create a PROMIS DIF file or PMS-II SDF file representation of its network or networks if several are used.

For PROMIS a record type 4 (Activity Data) DIF file must be created via the PROMIS UTILITY menu function; refer to the section on CREATE DATA INTERCHANGE FILE in the PROMIS reference manual. In response to the query to provide cost and resource data, the answer should be "Yes".

Although any file name may be specified it is recommended that the name be formatted as "PROJECT-ID.DIF"; for example "MACS.DIF".

For PMS-II a SDF file must be created via the PMS-II UTILITY menu function.

The SDF file name is generated automatically by the PMS-II system. The format is of the form "NETWORK-NAME.TXT" prefixed by DT; for example "DTRAMP.TXT". A second SDF file is also produced but is not required for the ROLL-UP.

CORRELATION FILE

The Correlation file contains a list of definitions that establish the equivalences between the correlated milestone names in the major project network and those used in the program network.

This file will be produced once by the CASP Program Office when the correlation negotiations with the Major Project Office have been completed.

There are two CORRELATION files for each (major) project:

General Summary Correlation File
Site Summary Correlation File

These files contain the respective correlation milestone definitions (refer to Appendix C for an example). These files are formatted identically as follows:

Columns 1-14	Columns 15-19
"name of the correlated milestone in the project network"	"corresponding name of the correlated milestone in the program network"
100	MXAOK (1)
START	MXSTR (2)
1,100	RMAOK (3)
2500,2600	RMBID (4)

Examples 1 and 2 are applicable to projects that use the PROMIS system; examples 3 and 4 are applicable only to projects that use PMS-II.

Each CORRELATION file must have a specific name as follows

AAAAPROG.EQU
AAAASITE.EQU

Where AAAA is a 4 letter project identifier. Thus for RAMP the appropriate filename would be

RAMPPROG.EQU
RAMPPSITE.EQU

The project identifiers are logically coded in the ROLLUP program, and are established when a project is added to the ROLLUP menu (see Figure).

PROGRAM LEVEL NAMES

The rollup procedure uses record types **FILE** 1,2,3,4,5 DIF files of the program-level:

General Summary Network
Site Summary Network

These are created via the PROMIS UTILITY menu function. The names that are assigned to files 1,2,3,and 5 are arbitrary; however file 4 must be named:

CASPPROG.OLD
CASPSITE.OLD

respectively for the general summary and site summary networks.

The ROLLUP Program will create updated files with ACTUAL START/FINISH data from the (major) project. The newly formed files are named:

CASPPROG.NEW
CASPSITE.NEW

PROGRAM PROMPTS

The ROLLUP program is executed by entering the command "ROLLUP".

The next two user inputs identify the project, and type of rollup required (General Summary, Site Summary). The following input defines the file name of the project DIF (or SDF) file. No further inputs are required until the rollup process is completed. At this point a query appears requesting authority to swap the old and new program level activity files; the normal response is "Y".

The ROLLUP program then recycles to permit another rollup to be performed. Multiple repeated executions are possible only when the swap authorization is "Y". If "N" is entered then in effect the CASPPROG.OLD and CASPSITE.OLD files are not replaced by their "XXXXXXXX.NEW" counterparts.

NETWORK UPDATE

Once the rollup process has been completed for one or more major projects, a new program level PROMIS network must be formed. This is accomplished by using the READ DATA INTERCHANGE file function of the PROMIS UTILITY menu option.

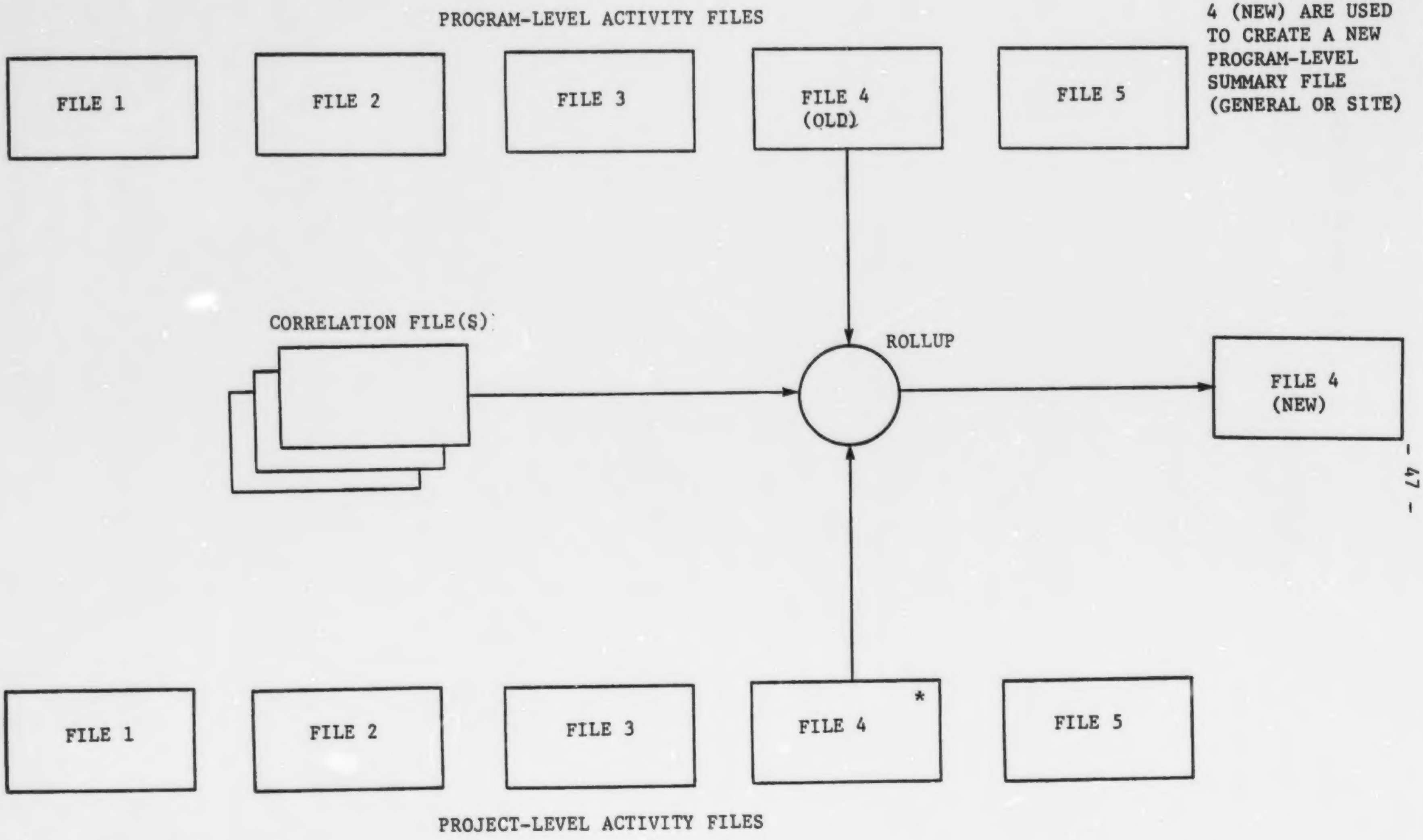
A new network name different from any existing name must be specified for:

General Summary Network
Site Summary Network

The files for Record types 1,2,3,4,5 must be loaded. The file names for 1,2,3 and 5 are the same as those specified when they were first unloaded. File 4 will be

CASPPROG.OLD
or CASPSITE.OLD

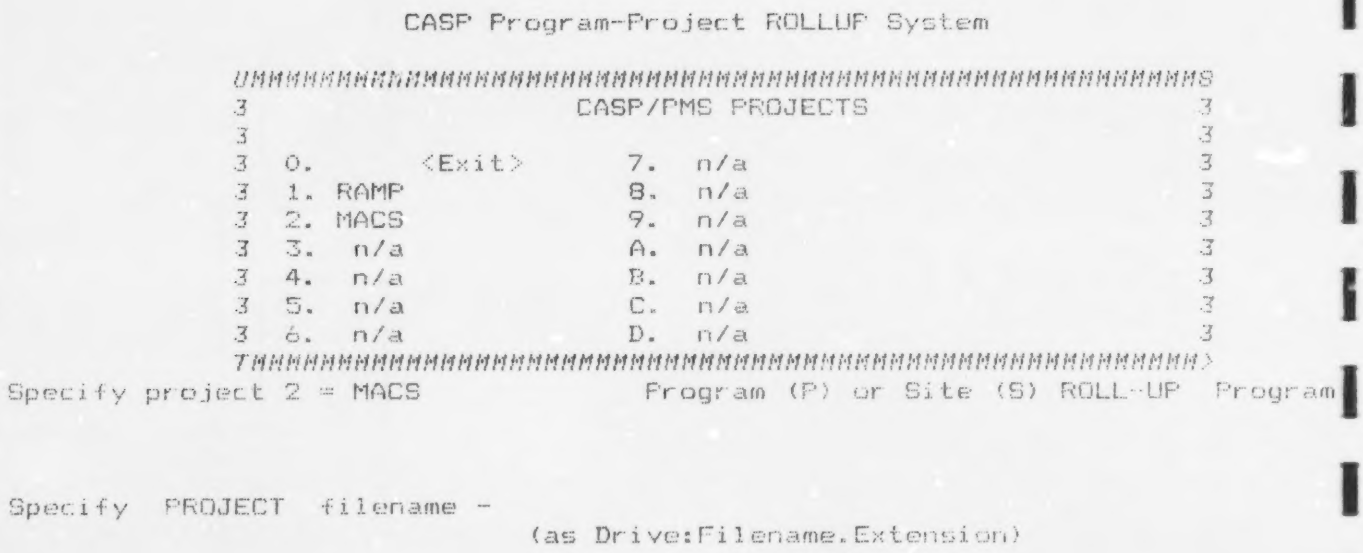
FIGURE 8: R UP SYSTEM FILES


PROGRAM-LEVEL ACTIVITY FILES
FILE 1
FILE 2
FILE 3
FILE 4 (OLD)
FILE 5
CORRELATION FILE(S)
ROLLUP
FILE 4 (NEW)
FILE 1
FILE 2
FILE 3
FILE 4 *
FILE 5
PROJECT-LEVEL ACTIVITY FILES

FILES 1,2,3,5 AND 4 (NEW) ARE USED TO CREATE A NEW PROGRAM-LEVEL SUMMARY FILE (GENERAL OR SITE)

* DTxxxx. TXT IF PMS-II

Figure 9 - ROLLUP MENU

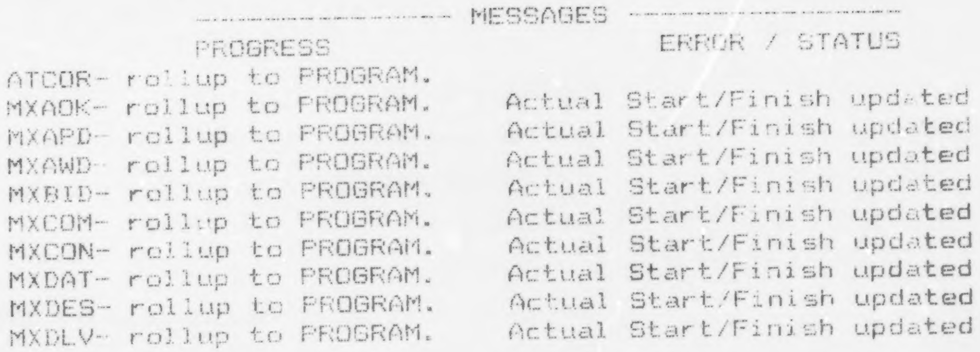


```
                    CASP Program-Project ROLLUP System

          UMMMMMMMMMMMMMMMMMMMMMMMMMMMMMMMMMMMMMMMMMMMMMMMMMMMMMMMMMMMMMMMMS
          3                        CASP/PMS PROJECTS                       3
          3                                                                3
          3  0.        <Exit>       7.  n/a                                3
          3  1. RAMP                8.  n/a                                3
          3  2. MACS                9.  n/a                                3
          3  3.  n/a                A.  n/a                                3
          3  4.  n/a                B.  n/a                                3
          3  5.  n/a                C.  n/a                                3
          3  6.  n/a                D.  n/a                                3
          7MMMMMMMMMMMMMMMMMMMMMMMMMMMMMMMMMMMMMMMMMMMMMMMMMMMMMMMMMMMMMMMM>
Specify project 2 = MACS            Program (P) or Site (S) ROLL-UP  Program


Specify  PROJECT  filename -
                              (as Drive:Filename.Extension)
```

Figure 10 - ROLLUP MESSAGES



```
              ------------ MESSAGES ------------
       PROGRESS                              ERROR / STATUS
ATCOR- rollup to PROGRAM.
MXAOK- rollup to PROGRAM.     Actual Start/Finish updated
MXAPD- rollup to PROGRAM.     Actual Start/Finish updated
MXAWD- rollup to PROGRAM.     Actual Start/Finish updated
MXBID- rollup to PROGRAM.     Actual Start/Finish updated
MXCOM- rollup to PROGRAM.     Actual Start/Finish updated
MXCON- rollup to PROGRAM.     Actual Start/Finish updated
MXDAT- rollup to PROGRAM.     Actual Start/Finish updated
MXDES- rollup to PROGRAM.     Actual Start/Finish updated
MXDLV- rollup to PROGRAM.     Actual Start/Finish updated
```

Recall however that this is the updated and renamed activity data file created by ROLLUP. An answer of "N" should be supplied in response to the query to use delimiters.

The READ DATA INTERCHANGE FILE operation must be performed twice, once for the site summary network, and again for the general summary network. In each case a different set of files 1,2,3,4,5 will be specified.

The new general and site summary networks may then be used after the PROMIS LOGIC VALIDATION and NETWORK ANALYSIS functions have been performed.

ROLLUP SUMMARY

The ROLLUP program is used to transfer ACTUAL START/FINISH data from major project correlation milestones to the corresponding program level correlation milestones.

There are two program level networks that are used to accomodate this information:

General Summary Network
Site Summary Network

ROLLUP has specific options to select either the general summary or the site summary for a particular target. ROLLUP performs one general or site rollup for one project at a time; it may however be rerun repeatedly as required.

Each major project must report its general and site progress for its respective correlated milestones at regular monthly reporting intervals. This is accomplished by creating a DIF file if PROMIS is used by the project of a SDF file if PMS-II is used. Each major project may provide one or more DIF or SDF files with general and/or site summary data for correlated milestones.

The program level creates new networks for the

General Summary Network
Site Summary Network

As a consequence of the rollup process. The previous network from the last reporting cycle as well as earlier networks may be retained for historical purposes provided storage space on disk permits.

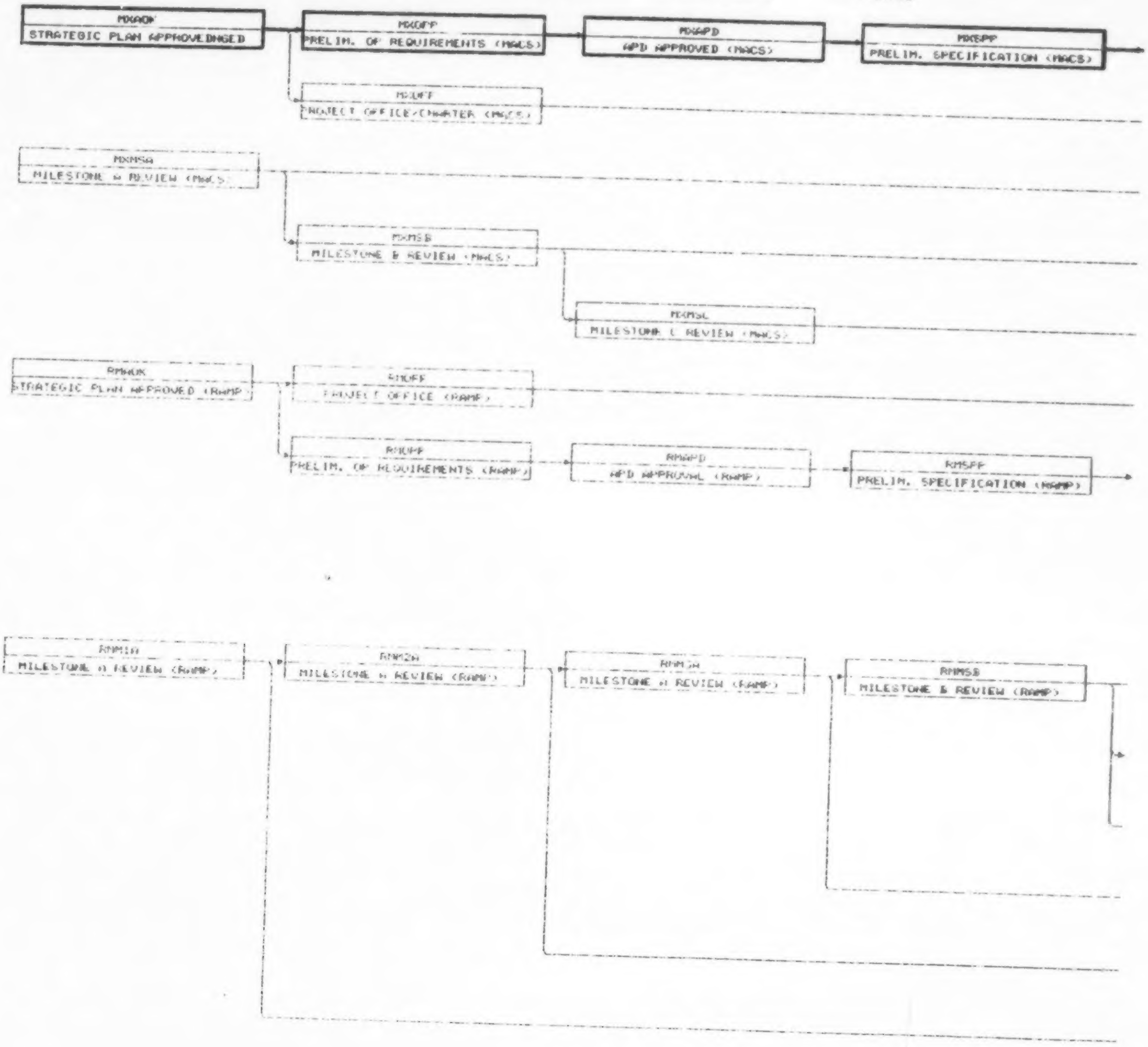
APPENDIX A

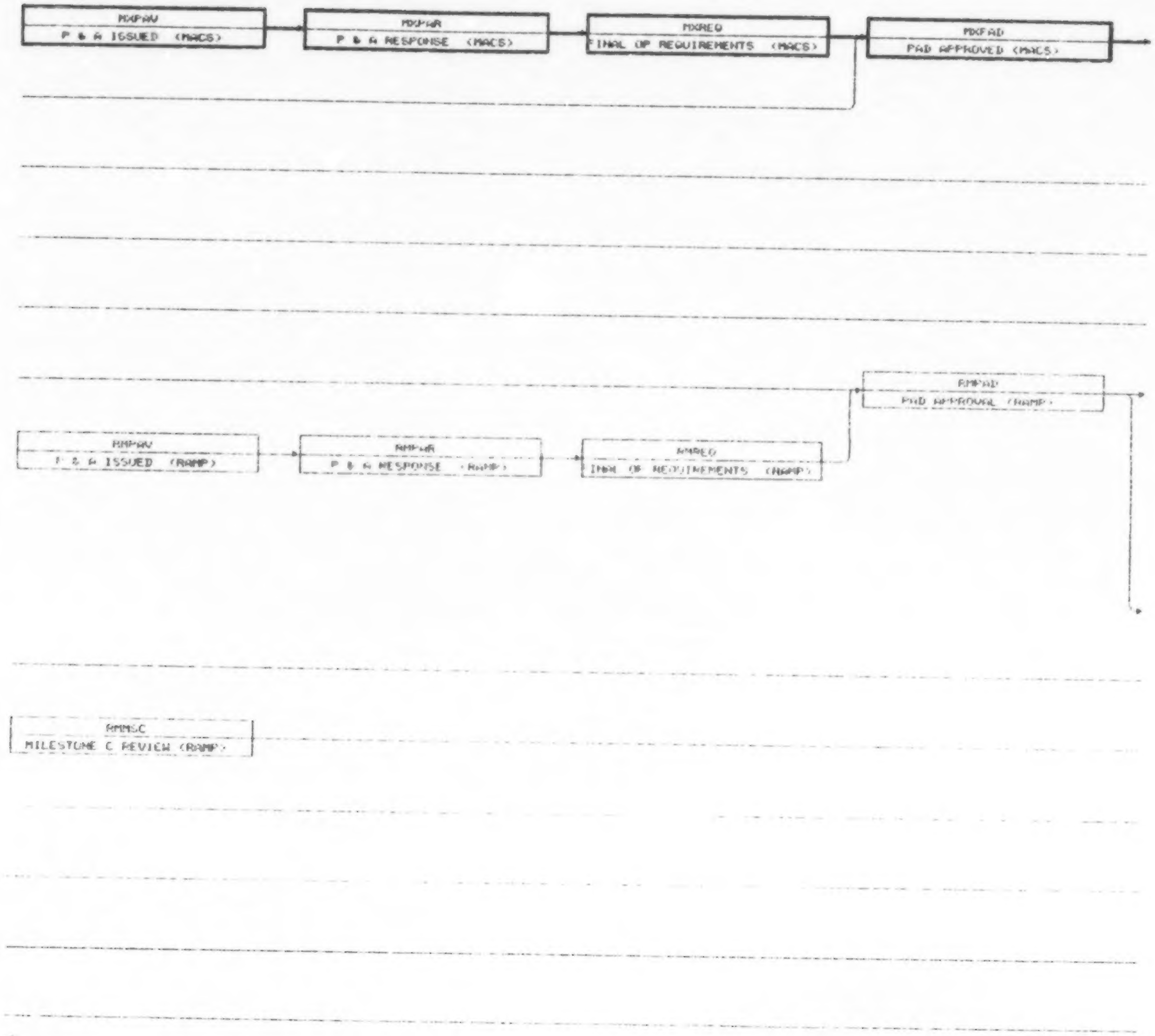
PROGRAM NETWORK DESCRIPTION:

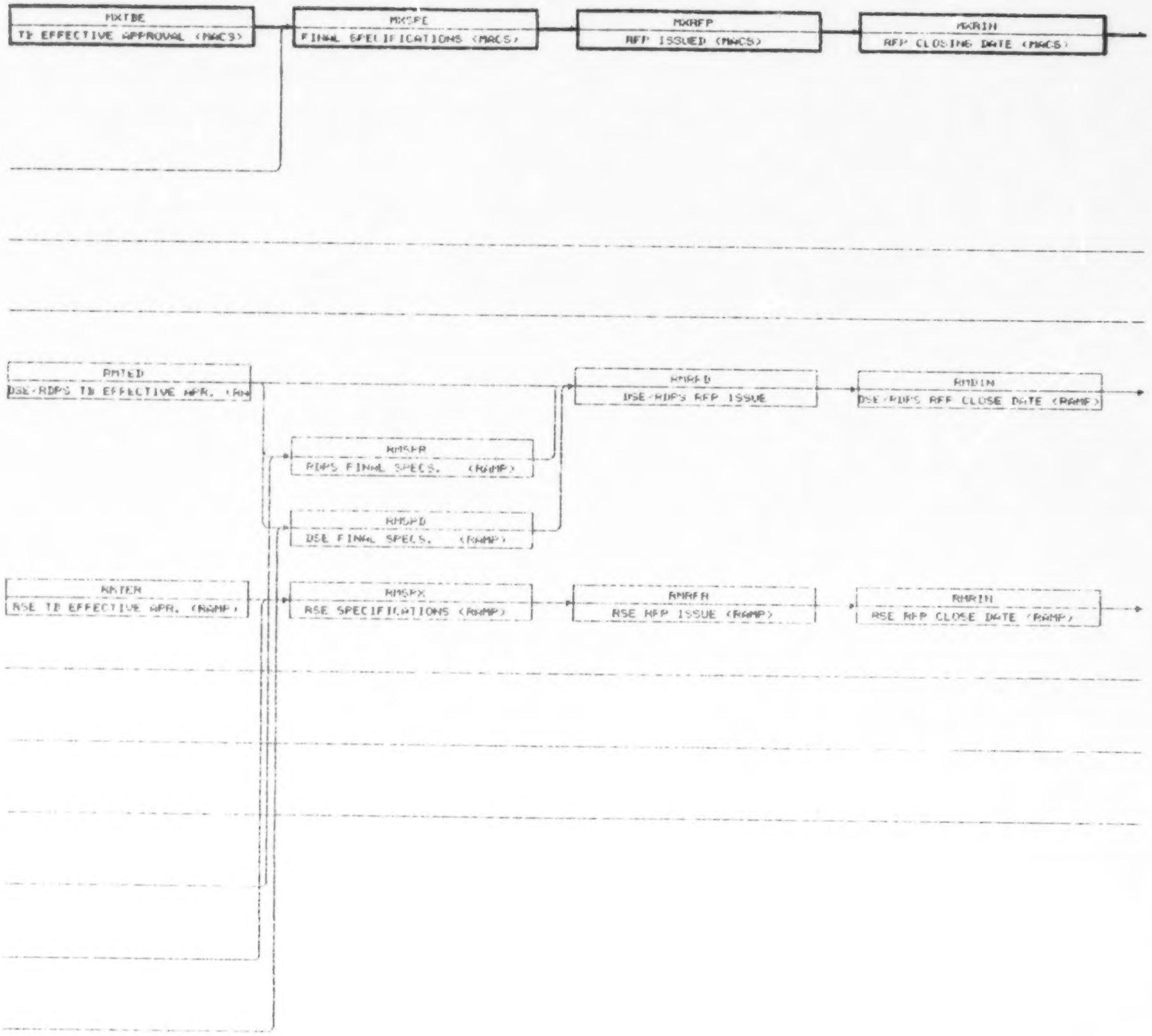
A1. GENERAL
A2. SITE

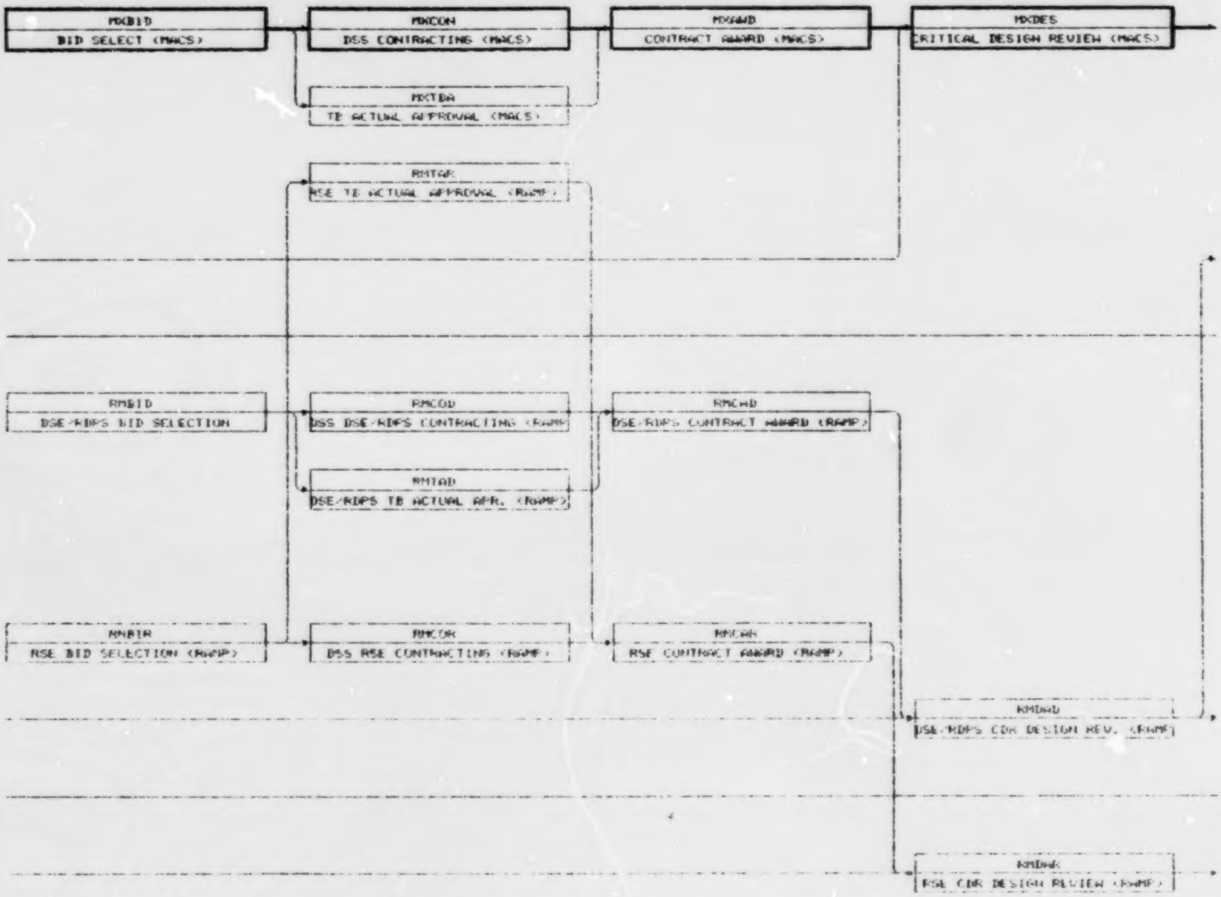
APPENDIX A1

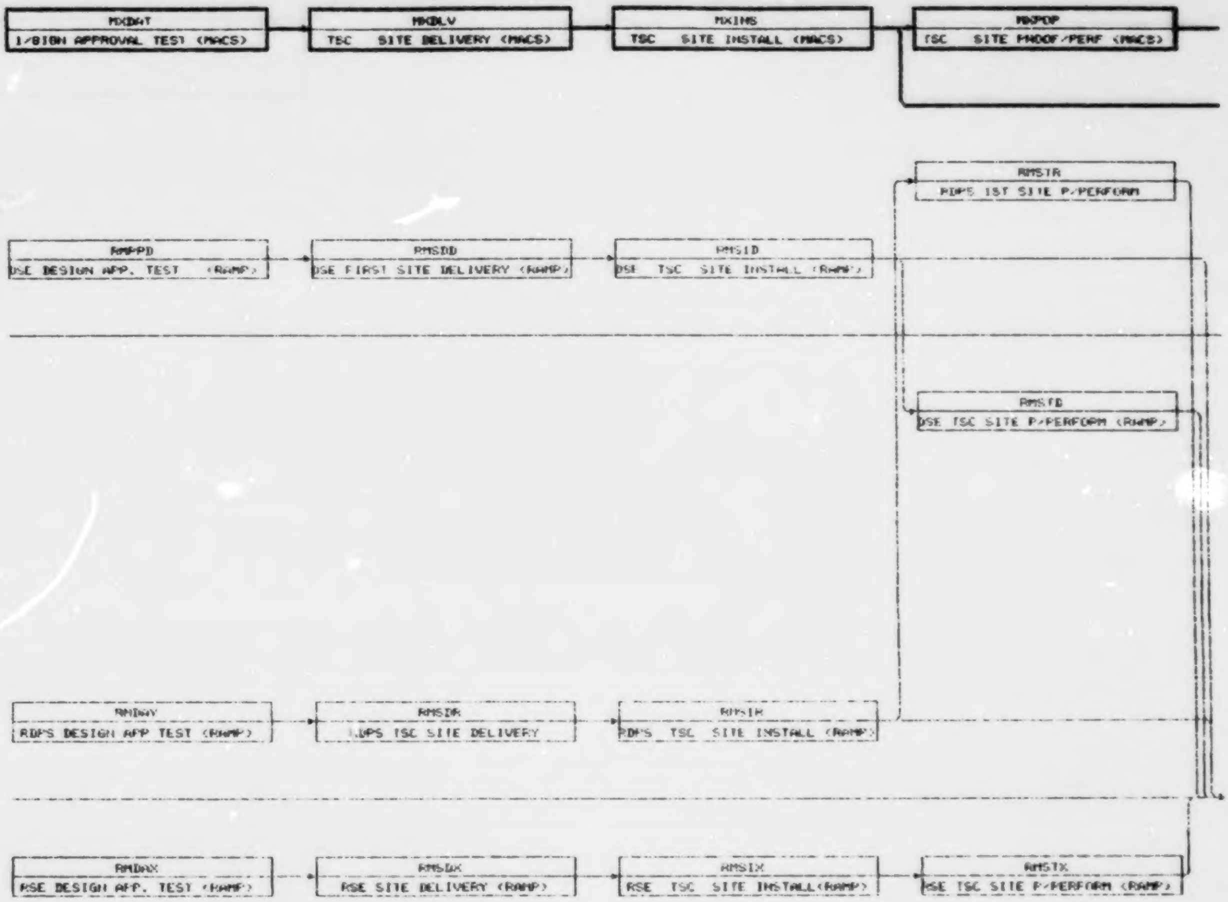
GENERAL SUMMARY PROGRAM NETWORK

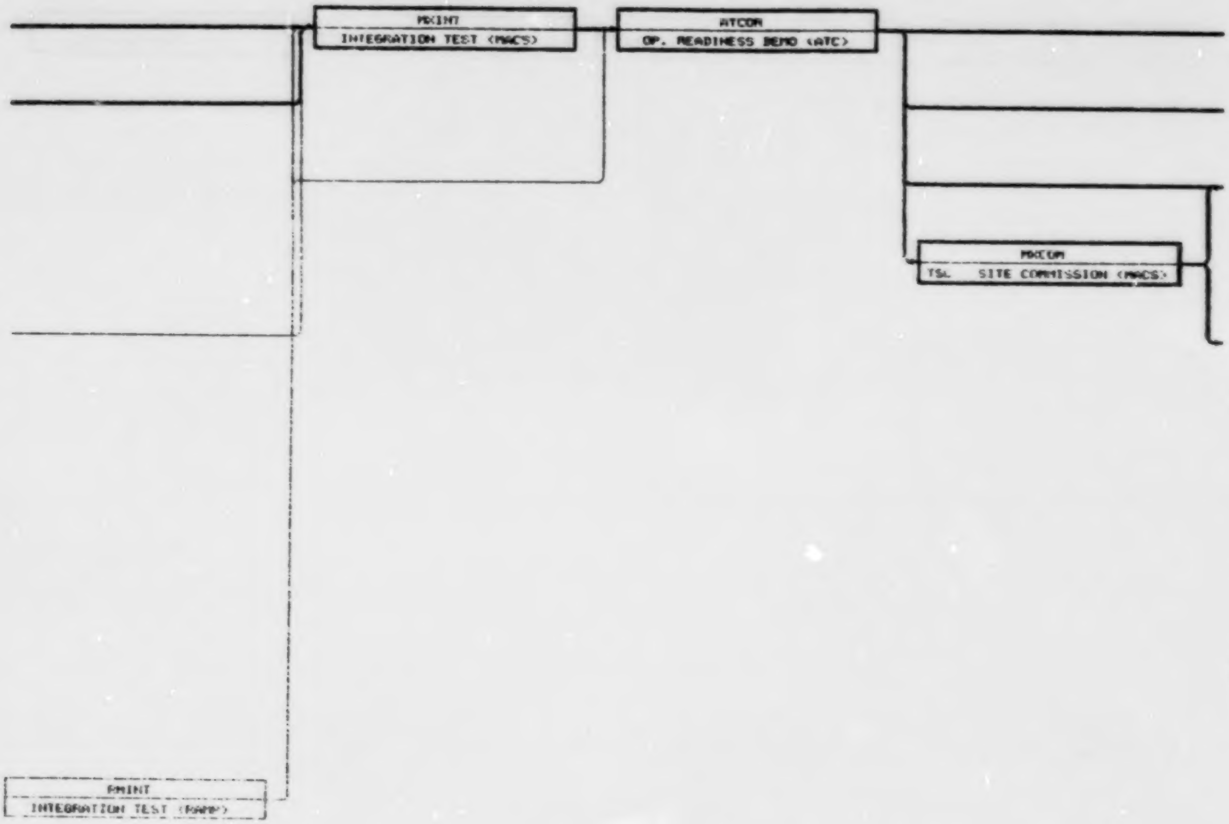

MXAOK
STRATEGIC PLAN APPROVEDNGED
MXOPP
PRELIM. OP REQUIREMENTS (MACS)
MXAPD
APD APPROVED (MACS)
MXSPP
PRELIM. SPECIFICATION (MACS)
MXOFF
PROJECT OFFICE/CHARTER (MACS)
MXMSA
MILESTONE A REVIEW (MACS)
MXMSB
MILESTONE B REVIEW (MACS)
MXMSC
MILESTONE C REVIEW (MACS)
RMAOK
STRATEGIC PLAN APPROVED (RAMP)
RMOFF
PROJECT OFFICE (RAMP)
RMOPP
PRELIM. OP REQUIREMENTS (RAMP)
RMAPD
APD APPROVAL (RAMP)
RMSPP
PRELIM. SPECIFICATION (RAMP)
RMM1A
MILESTONE A REVIEW (RAMP)
RMM2A
MILESTONE A REVIEW (RAMP)
RMM3A
MILESTONE A REVIEW (RAMP)
RMMSB
MILESTONE B REVIEW (RAMP)

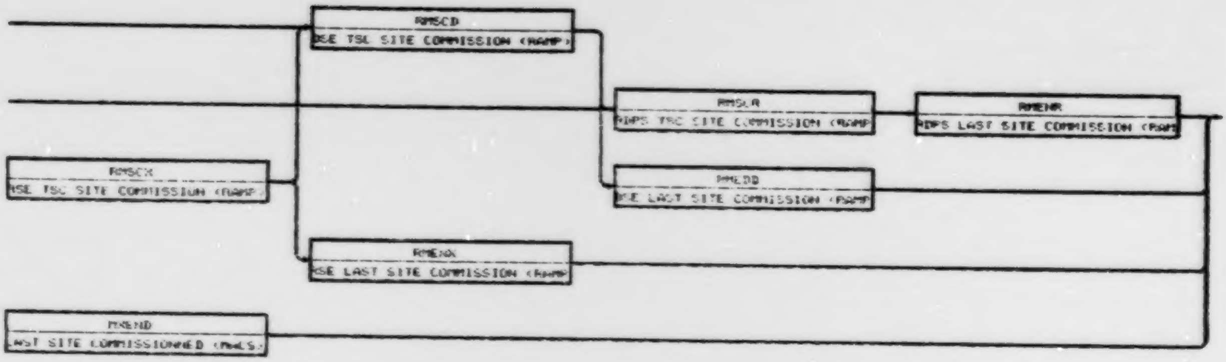

MXPAV
P & A ISSUED (MACS)
MXPWR
P & A RESPONSE (MACS)
MXREQ
FINAL OF REQUIREMENTS (MACS)
MXPAD
PAD APPROVED (MACS)
RMPAD
PAD APPROVAL (RAMP)
RMPAV
P & A ISSUED (RAMP)
RMPWR
P & A RESPONSE (RAMP)
RMREQ
INAL OF REQUIREMENTS (RAMP)
RMMSC
MILESTONE C REVIEW (RAMP)


MXTBE
TB EFFECTIVE APPROVAL (MACS)
MXSPE
FINAL SPECIFICATIONS (MACS)
MXRFP
RFP ISSUED (MACS)
MXRIN
RFP CLOSING DATE (MACS)
RMTED
DSE/RDPS TB EFFECTIVE APR. (RA
RMRFD
DSE/RDPS RFP ISSUE
RMDIN
DSE/RDPS RFP CLOSE DATE (RAMP)
RMSFR
RDPS FINAL SPECS. (RAMP)
RMSPD
DSE FINAL SPECS. (RAMP)
RMTER
RSE TB EFFECTIVE APR. (RAMP)
RMSPX
RSE SPECIFICATIONS (RAMP)
RMRFR
RSE RFP ISSUE (RAMP)
RMRIN
RSE RFP CLOSE DATE (RAMP)


MXBID
BID SELECT (MACS)
MXCON
DSS CONTRACTING (MACS)
MXAWD
CONTRACT AWARD (MACS)
MXDES
CRITICAL DESIGN REVIEW (MACS)
MXTBA
TB ACTUAL APPROVAL (MACS)
RMTAR
RSE TB ACTUAL APPROVAL (RAMP)
RMBID
DSE/RDPS BID SELECTION
RMCOD
DSS DSE/RDPS CONTRACTING (RAMP
RMCAD
DSE/RDPS CONTRACT AWARD (RAMP)
RMTAD
DSE/RDPS TB ACTUAL APR. (RAMP)
RMBIR
RSE BID SELECTION (RAMP)
RMCOR
DSS RSE CONTRACTING (RAMP)
RMCAR
RSE CONTRACT AWARD (RAMP)
RMDAD
DSE/RDPS CDR DESIGN REV. (RAMP)
RMDAR
RSE CDR DESIGN REVIEW (RAMP)


MXDAT
1/SIGN APPROVAL TEST (MACS)
MXDLV
TSC SITE DELIVERY (MACS)
MXINS
TSC SITE INSTALL (MACS)
MXPOP
TSC SITE PROOF/PERF (MACS)
RMSTR
RDPS 1ST SITE P/PERFORM
RMPPD
DSE DESIGN APP. TEST (RAMP)
RMSDD
DSE FIRST SITE DELIVERY (RAMP)
RMSID
DSE TSC SITE INSTALL (RAMP)
RMSTD
DSE TSC SITE P/PERFORM (RAMP)
RMDAY
RDPS DESIGN APP TEST (RAMP)
RMSDR
RDPS TSC SITE DELIVERY
RMSIR
RDPS TSC SITE INSTALL (RAMP)
RMDAX
RSE DESIGN APP. TEST (RAMP)
RMSDX
RSE SITE DELIVERY (RAMP)
RMSIX
RSE TSC SITE INSTALL(RAMP)
RMSTX
RSE TSC SITE P/PERFORM (RAMP)


MXINT
INTEGRATION TEST (MACS)
ATCOM
OP. READINESS DEMO (ATC)
MXCOM
TSL SITE COMMISSION (MACS)
RMINT
INTEGRATION TEST (RAMP)


RMSCD
DSE TSC SITE COMMISSION (RAMP)
RMSLA
RDPS TSC SITE COMMISSION (RAMP
RMEHR
RDPS LAST SITE COMMISSION (RAM
RMSCX
RSE TSC SITE COMMISSION (RAMP)
RMEDD
DSE LAST SITE COMMISSION (RAMP
RMENX
RSE LAST SITE COMMISSION (RAMP
MXEND
LAST SITE COMMISSIONNED (M&LS)

AMEND

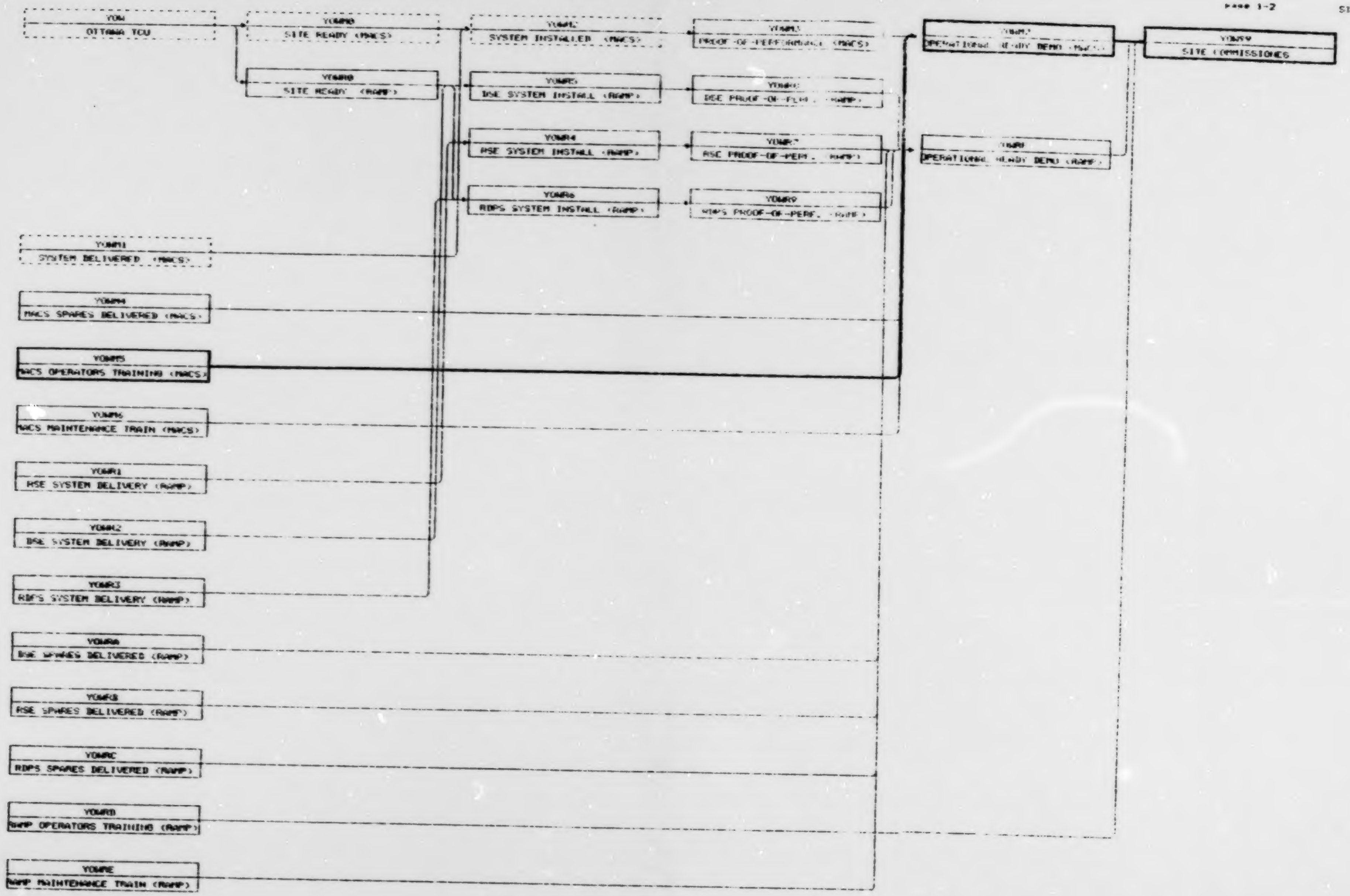
ALL SITES COMMISSIONED (RAMP)

APPENDIX A2

SITE SUMMARY PROGRAM NETWORK

PAGE 1-1 SITE SITE SUMMARY 9-19-85

PAGE 1-2 SITE SITE SUMMARY 9-19-85


YOW
OTTAWA TCU
YOWM0
SITE READY (MACS)
YOWR0
SITE READY (RAMP)
YOWM2
SYSTEM INSTALLED (MACS)
YOWR5
BSE SYSTEM INSTALL (RAMP)
YOWR4
RSE SYSTEM INSTALL (RAMP)
YOWR6
RDPS SYSTEM INSTALL (RAMP)
YOWM3
PROOF-OF-PERFORMANCE (MACS)
YOWR8
BSE PROOF-OF-PERF. (RAMP)
YOWR7
RSE PROOF-OF-PERF. (RAMP)
YOWR9
RDPS PROOF-OF-PERF. (RAMP)
YOWM7
OPERATIONAL READY DEMO (MACS)
YOWRF
OPERATIONAL READY DEMO (RAMP)
YOWS9
SITE COMMISSIONED
YOWM1
SYSTEM DELIVERED (MACS)
YOWM4
MACS SPARES DELIVERED (MACS)
YOWM5
MACS OPERATORS TRAINING (MACS)
YOWM6
MACS MAINTENANCE TRAIN (MACS)
YOWR1
RSE SYSTEM DELIVERY (RAMP)
YOWR2
BSE SYSTEM DELIVERY (RAMP)
YOWR3
RDPS SYSTEM DELIVERY (RAMP)
YOWRA
BSE SPARES DELIVERED (RAMP)
YOWRB
RSE SPARES DELIVERED (RAMP)
YOWRC
RDPS SPARES DELIVERED (RAMP)
YOWRD
RAMP OPERATORS TRAINING (RAMP)
YOWRE
RAMP MAINTENANCE TRAIN (RAMP)

APPENDIX B

B1. MACS MILESTONE DEFINITIONS FOR PROGRAM LEVEL

B2. MACS MILESTONE DEFINITIONS FOR SITE LEVEL

APPENDIX B1

MACS MILESTONE DEFINITIONS FOR PROGRAM LEVEL

CASP PROGRAM MANAGEMENT SYSTEM

PROGRAM MILESTONE DEFINITIONS FOR PROJECT MACS

6/2/85

PROGRAM LEVEL		PROJECT LEVEL		
MILESTONE I.D.	**EXTENDED MILESTONE DESCRIPTION**	**PLANNED DATE**	**MILESTONE I.D.**	**FILE NAME**
MXAOK	MACS project start date; strategic plan approved.			
MXAPD	Approval-in-Principle Document completed and approved.			
MXOPP	Preliminary operational requirements approved.			
MXOFF	Project office formed; project organization (charter) approved.			
MXPAV	Pricing and availability request to industry issued.			
MXSPP	Preliminary specifications approved.			
MXPAR	P&A closing date.			
MXPAD	Progrm Approval Document approved.			
MXREQ	Final Operational requirements completed, approved.			
MXMSA	CASP Program Office milestone review of specifications comopleted (CASP).			
MXSPE	Final specifications published, approved.			

CASP PROGRAM MANAGEMENT SYSTEM

PROGRAM MILESTONE DEFINITIONS FOR PROJECT MACS

6/2/85

PROGRAM LEVEL		PROJECT LEVEL		
MILESTONE I.D.	EXTENDED MILESTONE DESCRIPTION	PLANNED DATE	MILESTONE I.D.	FILE NAME
MXTBE	Treasury Board effective approval given.			
MXRFP	RFP Issues.			
MXRIN	RFP clossing date.			
MXBID	Winning proposal identified.			
MXTBA	Treasury board contract apprcval.			
MXCON	DSS contract documentation completed.			
MXAWD	Contract award.			
MXMSB	CASP Program office milestone review of contract completed (CASP).			
MXDES	Critical design review - approval.			
MXDAT	Design approval test passed.			
MXDLV	First site (TSC) delivery completed.			
MXINS	Install, test MACS at TSC site completed.			
MXPOP	Proof-of-performance at TSC site completed.			
MXINT	Integration tests completed.			

CASP PROGRAM MANAGEMENT SYSTEM

PROGRAM MILESTONE DEFINITIONS FOR PROJECT MACS

6/2/85

PROGRAM LEVEL		PROJECT LEVEL		
MILESTONE I.D.	**EXTENDED MILESTONE DESCRIPTION**	**PLANNED DATE**	**MILESTONE I.D.**	**FILE NAME**
MXMSC	CASP program office milestone review of integration testing completed (CASP)			
MXCOM	TSC site commissioned.			
MXEND	Last MACS site commissioned.			

LEGEND

PROJECT LEVEL milestones that have already been completed should have the actual date entered in the PLANNED DATE field.

The PROJECT LEVEL MILESTONES I.D. is the name of that milestone in the major project network that is correlated with the given PROGRAM LEVEL MILESTONES I.D.

The FILE NAME is the disc file name of the PROMIS data interchange file (in PROMIS pre-defined format) of the activity data (record type 4).

APPENDIX B2

MACS MILESTONE DEFINITIONS
FOR SITE LEVEL

CASP PROGRAM MANAGEMENT SYSTEM

PROGRAM MILESTONE DEFINITIONS FOR PROJECT MACS

6/2/85

PROGRAM LEVEL		PROJECT LEVEL			
MILESTONE I.D.	EXTENDED MILESTONE DESCRIPTION	PLANNED DATE	LOCATION ID	MILESTONE ID	FILE NAME
999M0	Site ready for MACS installation				
999M1	MACS systems delivered				
999M2	MACS systems installed				
999M3	MACS proof-of-performance test completed				
999M4	MACS systems spares delivered				
999M5	MACS operators training completed				
999M6	MACS maintenances trianing completed				
999M7	MACS operational readiness demonstration completed				
999M8	MACS-RAMP integration tests completed				
99999	Site commissioned				

LEGEND

Refer to the LEGEND in Appendix B1
The LOCATION ID is a unique two character location identifier that can be determined by reference to publication TP667.

APPENDIX C

C1. RAMP MILESTONE DEFINITIONS FOR PROGRAM LEVEL

C2. RAMP MILESTONE DEFINITIONS FOR SITE LEVEL

APPENDIX C1

RAMP MILESTONE DEFINITIONS
FOR PROGRAM LEVEL

CASP PROGRAM MANAGEMENT SYSTEM

PROGRAM MILESTONE DEFINITIONS FOR PROJECT RAMP

PROGRAM LEVEL		PROJECT LEVEL		
MILESTONE ID	EXTENDED MILESTONE DESCRIPTION	PLANNED DATE	MILESTONE ID	FILE NAME
RMAOK	RAMP Project start date; strategic plan approved.			
RMOFF	Project office formed; Project organization (charter) approved.			
RMAPD	Approval-in-Principle Document completed and approved.			
RMOPP	Preliminary operational requirements approved.			
RMSPP	Preliminary specifications approved.			
RMPAV	Pricing and Availability request to industry issued.			
RMPAR	P & A closing date.			

CASP PROGRAM MANAGEMENT SYSTEM

PROGRAM MILESTONE DEFINITIONS FOR PROJECT RAMP

PROGRAM LEVEL		PROJECT LEVEL		
MILESTONE ID	EXTENDED MILESTONE DESCRIPTION	PLANNED DATE	MILESTONE ID	FILE NAME
RMREQ	Final operational requirements completed, approved.			
RMPAD	Project Approval Document approved.			
RMTED	DSE/RDPS Treasury Board effective approval given.			
RMTER	RSE Treasury Board effective approval given.			
RMSPD	DSE final specifications published, approved.			
RMSPR	RDPS final specifications published, approved.			
RMSPX	RSE final specifications published, approved.			

CASP PROGRAM MANAGEMENT SYSTEM

PROGRAM MILESTONE DEFINITIONS FOR PROJECT RAMP

PROGRAM LEVEL		PROJECT LEVEL		
MILESTONE ID	EXTENDED MILESTONE DESCRIPTION	PLANNED DATE	MILESTONE ID	FILE NAME
RMM1A	CASP Program Office milestone review of DSE specifications completed (CASP).			
RMM2A	CASP Program Office milestone review of RDPS specifications completed (CASP).			
RMM3A	CASP Program Office milestone review of RSE specifications completed (CASP).			

CASP PROGRAM MANAGEMENT SYSTEM

PROGRAM MILESTONE DEFINITIONS FOR PROJECT RAMP

PROGRAM LEVEL		PROJECT LEVEL		
MILESTONE ID	**EXTENDED MILESTONE DESCRIPTION**	**PLANNED DATE**	**MILESTONE ID**	**FILE NAME**
RMRFD	DSE/RDPS RFP issued.			
RMRFR	RSE RFP issued.			
RMDIN	DSE/RDPS RFP closing date.			
RMRIN	RSE RFP closing date.			
RMBID	RSE/RDPS winning proposal identified.			
RMBIR	DSE winning proposal identified.			
RMTAD	DSE/RDPS Treasury Board contract approval.			
RMTAR	RSE Treasury Board contract approval.			

CASP PROGRAM MANAGEMENT SYSTEM

PROGRAM MILESTONE DEFINITIONS FOR PROJECT RAMP

PROGRAM LEVEL		PROJECT LEVEL		
MILESTONE ID	**EXTENDED MILESTONE DESCRIPTION**	**PLANNED DATE**	**MILESTONE ID**	**FILE NAME**
RMCOR	DDS RSE contract documentation completed.			
RMCOD	DSS DSE/RDPS contract documentation completed.			
RMMSB	CASP Program Office milestone review of contracts completed.			
RMCAD	DSE/RDPS contract award.			
RMCAR	RSE contract award.			
RMDAD	DSE/RSPS critical design review - approval.			
RMDAR	RSE critical design review - approval.			

CASP PROGRAM MANAGEMENT SYSTEM
PROGRAM MILESTONE DEFINITIONS FOR PROJECT RAMP

PROGRAM LEVEL		PROJECT LEVEL		
MILESTONE ID	EXTENDED MILESTONE DESCRIPTION	PLANNED DATE	MILESTONE ID	FILE NAME
RMDAX	RSE design approval test passed.			
RMDAY	DSE design approval test passed.			
RMDAZ	RDPS design approval test passed.			
RMSDD	DSE first site (TSC) delivery completed.			
RMSDX	RSE first site (TSC) delivery completed.			
RMSDR	RDPS first site (TSC) delivery completed.			
RMSIR	RDPS install, test (TSC) completed.			
RMSID	DSE install, test (TSC) completed.			
RMSIX	RSE install, test (TSC) completed.			

CASP PROGRAM MANAGEMENT SYSTEM
PROGRAM MILESTONE DEFINITIONS FOR PROJECT RAMP

PROGRAM LEVEL		PROJECT LEVEL		
MILESTONE ID	**EXTENDED MILESTONE DESCRIPTION**	**PLANNED DATE**	**MILESTONE ID**	**FILE NAME**
RMSTR	RDPS proof-of-performance (TSC) completed.			
RMSTD	DSE proof-of-performance (TSC) completed.			
RMSTX	RSE proof-of-performance (TSC) completed.			
RMINT	Integration tests completed.			
RMMXC	CASP Program Office milestone review of integration testing completed (CASP).			
RMSCD	DSE/RDPS 1st site (TSC) commissioned.			
RMSCX	RSE 1st site (TSC) commissioned.			

CASP PROGRAM MANAGEMENT SYSTEM

PROGRAM MILESTONE DEFINITIONS FOR PROJECT RAMP

PROGRAM LEVEL		PROJECT LEVEL		
MILESTONE ID	**EXTENDED MILESTONE DESCRIPTION**	**PLANNED DATE**	**MILESTONE ID**	**FILE NAME**
RMEDD	Last DSE site commissioned.			
RMENX	Last RSE site commissioned.			
RMENR	Last RDPS site commissioned.			
RMEND	All RAMP sites commissioned.			

LEGEND

PROJECT LEVEL milestones that have already been completed should have the actual date entered in the PLANNED DATE field.

LD.

The PROJECT LEVEL MILESTONE I.D. is the name of that milestone in the major project network that is correlated iwth the given PROGRAM LEVEL MILESTONE I.D.

The FILE NAME is the disc file name of the PMS-II data interchange file.

APPENDIX C2

RAMP MILESTONE DEFINITIONS
FOR SITE LEVEL

CASP PROGRAM MANAGEMENT SYSTEM

SITE MILESTONE DEFINITIONS FOR PROJECT RAMP

PAGE 1
OF 2
6/2/85

SITE LEVEL		PROJECT LEVEL			
MILESTONE ID	EXTENDED MILESTONE DESCRIPTION	PLANNED DATE	LOCATION ID	MILESTONE ID	FILE NAME
999R0	Site ready for RAMP installations.				
999R1	RSE systems delivered.				
999R2	DSE systems delivered.				
999R3	RDPS systems delivered.				
999RA	RSE systems spares delivered.				
999RB	DSE systems spares delivered.				
999RC	RDPS systems spares delivered.				

CASP PROGRAM MANAGEMENT SYSTEM

SITE MILESTONE DEFINITIONS FOR PROJECT RAMP

SITE LEVEL				PROJECT LEVEL	
MILESTONE ID	EXTENDED MILESTONE DESCRIPTION	PLANNED DATE	LOCATION ID	MILESTONE ID	FILE NAME
999RD	RAMP operations training completed.				
999RE	RAMP maintenance training completed.				
999R4	RSE systems installed.				
999R5	DSE systems installed.				
999R6	RDPS systems installed.				
999R7	RAMP proof-of-performance test completed. Test and accept (RSE).				
999R8	RAMP operational readiness demonstration completed.				
999R9	RAMP-MACS integration tests completed. Finish.				

LEGEND

Refer to the LEGEND in Appendix C1

The LOCATION I.D. is a unique two character location identifier that can be detrmined by reference to publication TP667.

APPENDIX D

MILESTONE DEFINITION FORMS

CASP PROGRAM MANAGEMENT SYSTEM

PROGRAM MILESTONE DEFINITIONS FOR PROJECT ____

PAGE 1
OF

PROGRAM LEVEL		PROJECT LEVEL		
MILESTONE ID	EXTENDED MILESTONE DESCRIPTION	PLANNED DATE	MILESTONE ID	FILE NAME

CASP PROGRAM MANAGEMENT SYSTEM
SITE MILESTONE DEFINITIONS FOR PROJECT ____

PAGE 1
OF

SITE LEVEL		PROJECT LEVEL			
MILESTONE ID	**EXTENDED MILESTONE DESCRIPTION**	**PLANNED DATE**	**LOCATION ID**	**MILESTONE ID**	**FILE NAME**

APPENDIX E

SPREADSHEET TEMPLATES

COST WORKSHEET

PROGRAM

	CURRENT YEAR											
	ACTUAL				FORECAST							
	APR	MAY	JUN	JUL	AUG	SEPT	OCT	NOV	DEC	JAN	FEB	MAR
CAPITAL COSTS (MILLIONS OF DOLLARS)												
Mojor Project 1	19.0	52.0	52.0	41.0	39.0	37.0	88.0	65.0	19.0	22.0	80.0	81.0
Major Project 2	7.0	9.0	12.0	12.0	23.0	12.0	34.0	23.0	0.0	3.0	8.0	0.0
Major Project 3	9.0	3.0	6.0	6.0	4.0	3.0	9.0	8.0	6.0	7.0	5.0	3.0
Total Capital	35.0	64.0	70.0	59.0	66.0	52.0	131.0	96.0	25.0	32.0	93.0	84.0
OPERATING COSTS(MILLIONS OF DOLLARS)												
Mojor Project 1	0.06	0.15	0.24	0.33	0.42	0.51	0.60	0.69	0.78	0.87	0.96	1.05
Major Project 2	0.02	0.05	0.08	0.11	0.14	0.17	0.20	0.23	0.26	0.29	0.32	0.35
Major Project 3	0.03	0.06	0.09	0.12	0.15	0.18	0.21	0.24	0.27	0.30	0.33	0.36
Total Operating	0.11	0.26	0.41	0.56	0.71	0.86	1.01	1.16	1.31	1.46	1.61	1.76
TOTAL COSTS	35.1	64.3	70.4	59.6	66.7	52.9	132.0	97.2	26.3	33.5	94.6	85.8
RESOURCES (PERSON YEARS)												
Mojor Project 1	2.0	1.2	2.0	2.6	3.9	4.5	5.0	6.3	6.9	7.8	8.3	9.0
Major Project 2	0.1	0.1	0.3	0.5	0.7	0.9	1.1	1.3	1.5	1.7	1.9	2.1
Major Project 3	0.0	0.2	0.4	0.6	0.8	1.0	1.2	1.4	1.6	1.8	2.0	2.2
Total Resources	2.1	1.5	2.7	3.7	5.4	6.4	7.3	9.0	10.0	11.3	12.2	13.3
MACS												
Total Capital	19.0	52.0	52.0	41.0	39.0	37.0	88.0	65.0	19.0	22.0	80.0	81.0
Total Operating	0.1	0.2	0.2	0.3	0.4	0.5	0.6	0.7	0.8	0.9	1.0	1.1
Total Resources	2.0	1.2	2.0	2.6	3.9	4.5	5.0	6.3	6.9	7.8	8.3	9.0

	CURRENT YEAR					MULTI-YEAR							PREVIOUS	FUTURE	TOTAL
						ACTUAL		FORECAST							
	FORECAST	BUDGET	COMMITED	EXPENDED	VALUE COMPLETED	83/84	84/85	85/86	86/87	87/88	88/89	89/90	YEARS EXPENDED	YEARS FORECAST	ESTIMATED COST
CAPITAL COSTS (MILLIONS OF DOLLARS)															
Mojor Project 1	595.0	458.0	350.0	220.0	260.0	34.0	165.0	595.0	813.0	594.0	404.0	198.0	199.0	2009.0	2803.0
Major Project 2	143.0	133.0	120.0	120.0	110.0	0.0	45.0	143.0	100.0	200.0	137.0	0.0	45.0	437.0	625.0
Major Project 3	69.0	60.0	0.0	0.0	0.0	0.0	0.0	69.0	23.0	54.0	67.0	78.0	0.0	222.0	291.0
Total Capital	807.0	651.0	470.0	340.0	370.0	34.0	210.0	807.0	936.0	848.0	608.0	276.0	244.0	2668.0	3719.0
OPERATING COSTS(MILLIONS OF DOLLARS)															
Mojor Project 1	6.66	6.30	3.00	1.50	1.10	4.50	9.00	6.66	2.25	4.50	6.75	9.00	13.50	22.50	42.66
Major Project 2	2.2	2.0	1.0	0.7	0.5	1.50	3.00	2.22	0.75	1.50	2.25	3.00	4.5	7.5	14.2
Major Project 3	2.3	2.3	1.0	0.0	0.0	2.00	3.50	2.34	1.00	1.75	2.50	3.25	5.5	8.5	16.3
Total Operating	11.2	10.6	5.0	2.2	1.6	8.00	15.50	11.22	4.00	7.75	11.50	15.25	23.5	38.5	73.2
TOTAL COSTS	818.2	661.6	475.0	342.2	371.6	42.0	225.5	818.2	940.0	855.8	619.5	291.3	267.5	2706.5	3792.2
RESOURCES (PERSON YEARS)															
Mojor Project 1	59.5	57.5	115.8	171.3	284.5	10.0	19.0	59.5	10.0	22.5	35.0	47.5	29.0	115.0	203.5
Major Project 2	12.2	11.0	10.0	5.0	6.0	1.0	3.0	12.2	1.5	4.0	6.5	9.0	4.0	21.0	37.2
Major Project 3	12.7	11.0	9.0	3.0	6.0	1.5	3.5	12.7	2.0	4.5	7.0	9.5	5.0	23.0	40.7
Total Resources	84.4	82.3	165.2	144.8	406.3	12.5	25.5	84.4	13.5	31.0	48.5	66.0	38.0	159.0	281.4
MACS															
Total Capital	595.0	458.0	350.0	220.0	260.0	34.0	165.0	595.0	813.0	594.0	404.0	198.0	199.0	2009.0	2803.0
Total Operating	6.7	6.3	3.0	1.5	1.1	4.5	9.0	6.7	2.3	4.5	6.8	9.0	13.5	22.5	42.7
Total Resources	59.5	57.5	115.8	171.3	284.5	10.0	19.0	59.5	10.0	22.5	35.0	47.5	29.0	115.0	203.5

```
MAJOR PROJECT 1

                    --------------------CURRENT YEAR---------------------- ------------------   --------------CURRENT YEAR---------- ----------   ------------MULTI-YEAR ------------------- PREVIOUS   FUTURE    TOTAL
                    ------------ACTUAL------   ------------FORECAST------- ------------------                                                    ACTUAL------      ------FORECAST----------
                       APR   MAY   JUN   JUL   AUG  SEPT   OCT   NOV   DEC    JAN   FEB   MAR    FORECAST   BUDGET COMMITED EXPENDED      VALUE    83/84 84/85 85/86 86/87 87/88 88/89 89/90    YEARS    YEARS ESTIMATED
                                                                                                                                      COMPLETED                                              EXPENDED FORECAST     COST
CAPITAL COSTS (MILLIONS OF DOLLARS)
Contract 1             4.0  40.0  34.0  23.0  12.0  22.0  45.0  34.0  13.0   12.0  67.0  78.0       384.0    265.0    230.0    100.0      150.0     34.0 120.0 384.0 450.0 340.0 200.0 120.0    154.0   1110.0   1648.0
Contract 2             6.0   9.0  12.0  12.0  23.0  12.0  34.0  23.0   0.0    3.0   8.0   0.0       142.0    133.0    120.0    120.0      110.0      0.0  45.0 142.0 340.0 200.0 137.0   0.0     45.0    677.0    864.0
Contract 3             9.0   3.0   6.0   6.0   4.0   3.0   9.0   8.0   6.0    7.0   5.0   3.0        69.0     60.0      0.0      0.0        0.0      0.0   0.0  69.0  23.0  54.0  67.0  78.0      0.0    222.0    291.0
-------------------------------------------------------------------------- ------------------   ------------------------------------ ----------   ------------------------------------------ --------------------------
Total Capital         19.0  52.0  52.0  41.0  39.0  37.0  88.0  65.0  19.0   22.0  80.0  81.0       595.0    458.0    350.0    220.0      260.0     34.0 165.0 595.0 813.0 594.0 404.0 198.0    199.0   2009.0   2803.0
-------------------------------------------------------------------------- ------------------   ------------------------------------ ----------   ------------------------------------------ --------------------------
CUMM. CAPITAL         19.0  71.0 123.0 164.0 203.0 240.0 328.0 393.0 412.0  434.0 514.0 595.0

OPERATING COSTS (MILLIONS OF DOLLARS)
Overtime              0.01  0.04  0.07  0.10  0.13  0.16  0.19  0.22  0.25   0.28  0.31  0.34         2.1      2.0      1.0      0.8        0.6     1.00  2.50  2.10  0.50  1.25  2.00  2.75      3.5      6.5     12.1
Travel                0.02  0.05  0.08  0.11  0.14  0.17  0.20  0.23  0.26   0.29  0.32  0.35         2.2      2.0      1.0      0.7        0.5     1.50  3.00  2.22  0.75  1.50  2.25  3.00      4.5      7.5     14.2
Miscellaneous         0.03  0.06  0.09  0.12  0.15  0.18  0.21  0.24  0.27   0.30  0.33  0.36         2.3      2.3      1.0      0.0        0.0     2.00  3.50  2.34  1.00  1.75  2.50  3.25      5.5      8.5     16.3
-------------------------------------------------------------------------- ------------------   ------------------------------------ ----------   ------------------------------------------ --------------------------
Total Operating       0.06  0.15  0.24  0.33  0.42  0.51  0.60  0.69  0.78   0.87  0.96  1.05         6.7      6.3      3.0      1.5        1.1     4.50  9.00  6.66  2.25  4.50  6.75  9.00     13.5     22.5     42.7
-------------------------------------------------------------------------- ------------------   ------------------------------------ ----------   ------------------------------------------ --------------------------
TOTAL COSTS           19.1  52.2  52.2  41.3  39.4  37.5  88.6  65.7  19.8   22.9  81.0  82.1       601.7    464.3    353.0    221.5      261.1     38.5 174.0 601.7 815.3 598.5 410.8 207.0    212.5   2031.5   2845.7
========================================================================== ==================   ==================================== ==========   ========================================== ==========================

RESOURCES (PERSON YEARS)
Managers               3.0   0.5   0.5   0.3   0.8   0.6   0.3   0.8   0.6    0.7   0.4   0.3         8.8      4.0      3.0      2.0        3.0      3.0   4.0   8.8   1.0   3.5   6.0   8.5      7.0     19.0     34.8
Engineers              1.5   0.1   0.3   0.5   0.7   0.9   1.1   1.3   1.5    1.7   1.9   2.1        13.6     11.0     10.0      5.0        6.0      1.0   3.0  13.6   1.5   4.0   6.5   9.0      4.0     21.0     38.6
Technicians            0.0   0.2   0.4   0.6   0.8   1.0   1.2   1.4   1.6    1.8   2.0   2.2        12.7     11.0      9.0      3.0        6.0      1.5   3.5  12.7   2.0   4.5   7.0   9.5      5.0     23.0     40.7
System Analysts        0.0   0.2   0.4   0.6   0.8   1.0   1.2   1.4   1.6    1.8   2.0   2.2        13.2     12.0     11.0      8.0        3.0      2.0   4.0  13.2   2.5   5.0   7.5  10.0      6.0     25.0     44.2
Support Staff          0.4   0.3   0.5   0.7   0.9   1.1   1.3   1.5   1.7    1.9   2.1   2.3        14.2     12.0      7.0      4.0        2.0      2.5   4.5  14.2   3.0   5.5   8.0  10.5      7.0     27.0     48.2
-------------------------------------------------------------------------- ------------------   ------------------------------------ ----------   ------------------------------------------ --------------------------
Total Resources        4.9   1.2   2.0   2.6   3.9   4.5   5.0   6.3   6.9    7.8   8.3   9.0        62.4     57.5    118.7    174.2      290.3     10.0  19.0  62.4  10.0  22.5  35.0  47.5     29.0    115.0    206.4
========================================================================== ==================   ==================================== ==========   ========================================== ==========================


MACS
Total Capital         19.0  52.0  52.0  41.0  39.0  37.0  88.0  65.0  19.0   22.0  80.0  81.0       595.0    458.0    350.0    220.0      260.0     34.0 165.0 595.0 813.0 594.0 404.0 198.0    199.0   2009.0   2803.0
Total Operating        0.1   0.2   0.2   0.3   0.4   0.5   0.6   0.7   0.8    0.9   1.0   1.1         6.7      6.3      3.0      1.5        1.1      4.5   9.0   6.7   2.3   4.5   6.8   9.0     13.5     22.5     42.7
Total Resources        4.9   1.2   2.0   2.6   3.9   4.5   5.0   6.3   6.9    7.8   8.3   9.0        62.4     57.5    118.7    174.2      290.3     10.0  19.0  62.4  10.0  22.5  35.0  47.5     29.0    115.0    206.4
```

APPENDIX F

TERMINOLOGY

INTRODUCTION

This section provides descriptions of many of the working terms and concepts that are used in the definition of the CASP Program Management System.

This section is intended to function as more than a dictionary. The terms are arranged in order to permit the logical grouping of related terms, and a presentation sequence that is tutorial. This section is essential for understanding the material that is presented in the subsequent sections.

NETWORK
EVENT

Any project that has a definite beginning and a completion and is comprised of a finite number of activities, can be represented as a model by means of NETWORK programming techniques. In defining the network, each activity (a logical aggregate of work) must be assigned a definite start and end point, and these points are called EVENTS. Each activity has a (non-zero) time duration and it is always delimited by events; the events have no time duration. A project may then be represented as a combination of interrelated activities connected by events. Each event represents the start or end of one or more activities.

Two network diagramming techniques are available to depict a network model.

ACTIVITY-ON-ARROW and PRECEDENCE, are network diagramming techniques.

ACTIVITY-ON-ARROW

In an ACTIVITY-ON-ARROW diagram each activity is represented by an arrow; the tail of the arrow indicates the start of the activity, the head indicates the end; the length of the arrow has no significance. Thus a series of arrows arranged head-to-tail represents a sequence of activities. The arrows are separated by small circles that represent the start and end events and are termed NODES.

NODES

ACTIVITY-ON-ARROW NETWORK DIAGRAM

The NODES are numbered in a consistent manner and activities can then be uniquely identified. In the figure above there is a 2-3 activity and a 2-4 activity that can proceed concurrently.

PRECEDENCE

The activities in a PRECEDENCE diagram are depicted by rectangular boxes, and the interrelationships of the activities are shown by arrows. The start and end events in a precedence network are represented by the leading and trailing edges of the activity boxes.

PRECEDENCE NETWORK DIAGRAM

COMPARISON ACTIVITY-ON-ARROW vs PRECEDENCE

The network models that result from the activity-on-arrow and precedence diagramming techniques contain exactly the same project information. However there is an advantage to using the precedence technique when there are many parallel project activities.

The PRECEDENCE Network allows greater flexibility on defining the conditions for starting or finishing an activity. Typically the start an activity may be dependent of the finish of the preceeding activity (a finish-to-start precedence relationship). However, other precedences including finish-to-finish and start-to-start may be required and are easily accommodated using the PRECEDENCE approach.

The CASP Program Management System can use either the ACTIVITY-ON-ARROW or the PRECEDENCE technique. However the precedence method is the recommended CASP/PMS approach.

MILESTONE

A MILESTONE is a project event that has particular significance (such as the end of the design phase). The CASP/PMS system uses a unique approach of using activities having zero-time duration as MILESTONES. In this case the leading and the trailing edges of the precedence activity box can be implicitly envisioned to coincide thereby creating a special event, the MILESTONE.

LAG

Between activities in a network a LAG duration may be defined. The LAG represents the minimum time which must elapse between two connected activities. For example,

Issued RFP	21	Closing Date
June 30		July 31

between the issue of an RFP, and the proposal due date, there is a lag of say, 21 days. That is to say, at least 21 days are required between the two events. There are 31 days between the issue of the RFP on June 30, and the closing date on July 31. Thus the issue date can slip up to 10 days without affecting the overall schedule. Any additional slip, would result in a delay in the closing date, of July 31.

SUB-NETWORK

When network models get very large, or when certain sequences of activities tend to be repeated at different stages, it may be advisable to create a sub-network. The sub-network is a stand-alone segment of a network.

The sub-network is defined in a manner analogous to that for the main network. However, the sub-network is usually restricted to having a single start event and a single end event. This restriction simplifies the interface between the main network and the subnetwork.

The sub-network in an ACTIVITY-ON-ARROW model can be used to replace the single activity between any start-end node; the sub-network in a PRECEDENCE model can be used to replace any activity box (or boxes). The activities in a sub-network may proceed in parallel with the activities in the main network.

Each major project may impact one or more other major projects, and may in turn be impacted by them, however the major schedule, cost and resource dependencies exist largely within each major project. A hierarchial activity structure such as is shown in Figure 1 has been developed to represent the CASP program.

The CASP theme is that safety, capacity, productivity and economy will be achieved through higher levels of technology and automation. In a parallel context the effective systems engineering management implementation for the CASP program will be achieved through the application of automated program management technology; this technology, the CASP Program Management System is described in this document.

APPENDIX G

DOCUMENTATION

G: DOCUMENTATION

POLICY DOCUMENTS

Transport Canada project management policy is defined in:

PROJECT MANAGEMENT
POLICY AND GUIDELINES (TP 3867)

Further information describing the policy on which the CASP Program Management System is based can be obtained from the following Chapters of the Treasury Board (TB) Administrative Policy Manual:

Chapter 140:	Management of Major
Chapter 141:	Leaders of Major Projects
Chapter 142:	Decision-making Information for Major Projects
Chapter 143:	Progress Reporting for Major Projects
Chapter 148:	Cost Control of Projects
Chapter 310:	Contracting

BACKGROUND DOCUMENT

Additional information on the CASP Program Management System strategy can be found in:

Systems Engineering Management
Implementation Plan for the Canadian
Airspace System -
Summary Report

OTHER DOCUMENTS

An additional reference document that is used in the CASP Program Management System is:

Canadian Location Identifiers
Air Administration (TP667)

Software program reference material is contained in the users reference manuals for

PROMIS
PMS II and
LOTUS 1-2-3

APPENDIX H

SAMPLE OUTPUT REPORT FROM PROMIS

PROMIS REPORTS

This appendix contains a list and a sample of each of the PROMIS reports.

TABULAR OUTPUT

REPORT ID	TITLE
337	Project Calendar
511-1	Time Analysis - Target Schedule
511-2	Milestone Report - Target Schedule
511-3	Detailed Time Analysis - Target Schedule
512-1	Resource Requirement By Activity
512-2	Resource Requirement By Resource
512-3	Excess Resource Requirement
513-1	Summary Cost Estimates By Activity - Target Schedule
513-2	Detailed Cost Estimates By Activity - Target Schedule
513-3	Resource Costing Report - Target Schedule
513-4	Baseline Cashflow - Early Schedule - Daily
513-4	Baseline Cashflow - Early Schedule - Weekly
513-4	Baseline Cashflow - Early Schedule - Monthly
521-1	Time Analysis - Progress To-Date
521-2	Milestone Report - Progress To-Date
521-3	Detailed Time Analysis - Progress To-Date
522-1	Resource Usage By Activity
522-2	Resource Usage By Resource
522-3	Excess Resource Usage By Resource
523-1	Summary Cost Estimates By Activity - Actual Schedule
523-2	Detailed Cost Estimates By Activity - Actual Schedule
523-3	Resource Costing Report - Actual Costs
523-4	Actual Cashflow - Early Schedule - Daily
523-4	Actual Cashflow - Early Schedule - Weekly
523-4	Actual Cashflow - Early Schedule - Monthly
523-5	Earned Value Analysis By Activity
523-6	Earned Value Analysis By Time Period - Weekly
523-6	Earned Value Analysis By Time Period - Monthly
541-1	Activity Input Listing
541-2	Network Logic
541-3	Resource Requirements Listing
541-4	Fixed Costs - Listings By Activity
541-5	Precedence Relationships
541-6	Milestone Listing
542-1	Actual Schedule Listing
542-2	Resource Usage Listing
542-3	Actual Cost Listing
543-1	Project Holiday Table
543-2	Project Resource Table
614	Work Week Code Listing
615	Standard Holiday Table
616	Standard Resource Table
634	Project Input Listing

GRAPHICS OUTPUT

Single Project

REPORT ID	TITLE
531	Gantt Chart
532	Resource Profile (Periodic)
532	Resource Profile (Periodic & Cumulative)
533	Cost Profile (Periodic)
533	Cost Profile (Periodic & Cumulative)
534	Cash Flow (Periodic)
534	Cash Flow (Periodic & Cumulative)
535	Network Diagram

Multiple Project (up to 3)

REPORT ID	TITLE
532	Resource Profile (Periodic)
532	Resource Profile (Periodic & Cumulative)
533	Cost Profile (Periodic)
533	Cost Profile (Periodic & Cumulative)
534	Cash Flow (Periodic)
534	Cash Flow (Periodic & Cumulative)

```
Date:  9/ 4/84                PROJECT CALENDAR
Project Id: HOUSE-2                                       CUMULATIVE
Project Start:  1/ 2/84                           WORK DAYS TO END OF RANGE
Calendar Base:  1/ 2/84
Print from:     1/ 2/84                                THIS    FROM   FROM START
         to:    1/31/84                         WWC    MONTH   BASE   OF RANGE
                                                ==============================
                                                5D/W    22      22       22

                               JANUARY 1984
                               ------------
      :----------:----------:----------:----------:----------:----------:----------:
 WWC  :  SUNDAY  :  MONDAY  : TUESDAY  :WEDNESDAY: THURSDAY :  FRIDAY  : SATURDAY :
      :----------:----------:----------:----------:----------:----------:----------:
      :    1     :    2     :    3     :    4     :    5     :    6     :    7     :
 5D/W :          :   [1]    :   [2]    :   [3]    :   [4]    :   [5]    :[WEEKEND] :
      :          :          :          :          :          :          :          :
      :----------:----------:----------:----------:----------:----------:----------:
      :    8     :    9     :   10     :   11     :   12     :   13     :   14     :
 5D/W :[WEEKEND] :   [6]    :   [7]    :   [8]    :   [9]    :   [10]   :[WEEKEND] :
      :          :          :          :          :          :          :          :
      :----------:----------:----------:----------:----------:----------:----------:
      :   15     :   16     :   17     :   18     :   19     :   20     :   21     :
 5D/W :[WEEKEND] :   [11]   :   [12]   :   [13]   :   [14]   :   [15]   :[WEEKEND] :
      :          :          :          :          :          :          :          :
      :----------:----------:----------:----------:----------:----------:----------:
      :   22     :   23     :   24     :   25     :   26     :   27     :   28     :
 5D/W :[WEEKEND] :   [16]   :   [17]   :   [18]   :   [19]   :   [20]   :[WEEKEND] :
      :          :          :          :          :          :          :          :
      :----------:----------:----------:----------:----------:----------:----------:
      :   29     :   30     :   31     :          :          :          :          :
 5D/W :[WEEKEND] :   [21]   :   [22]   :          :          :          :          :
      :          :          :          :          :          :          :          :
      :__________:__________:__________:__________:__________:__________:__________:
```

```
Date: 9/ 4/84                    ********************************************             Page   1
Project Id: HOUSE                *             House Construction           *      Last Acc: 9/ 4/84
                                 *               P R O M I S                *      Last Upd:
Project start: 1/ 1/84           ********************************************
                                                                                   Report #: 511-1
                                       TIME ANALYSIS - TARGET SCHEDULE

Selection: ACT[1000-1050]
====================================================================================================
                ACTIVITY                        EARLY/   EARLY/   PLANNED           ACTIVITY CODES
--------------------------------------- EST    LATE     LATE      START  TOTAL  FREE  ---------------------
ID   SUBPROJ   DESCRIPTION              DUR    START    FINISH           FLOAT FLOAT WBC RESP AUX1 AUX2 AUX3
====================================================================================================
1000           BEGIN CONSTRUCTION
                                          1   1/ 2/84  1/ 2/84              0     0  54 FM-B
                                              1/ 2/84  1/ 2/84

1010           EXCAVATE, POUR FOOTER
                                          4   1/ 3/84  1/ 6/84              0     0  54 FM-B
                                              1/ 3/84  1/ 6/84

1020           POUR CONCRETE FOUNDATIONS
                                          2   1/ 9/84  1/10/84              0     0  54 FM-A
                                              1/ 9/84  1/10/84

1030           ERECT FRAME AND ROOF
                                          4   1/11/84  1/16/84              0     0  54 FM-A
                                              1/11/84  1/16/84

1040           LAY BRICKWORK
                                          6   1/17/84  1/24/84              8     0  54 FM-A
                                              1/27/84  2/ 3/84

1050           INSTALL DRAINS
                                          1   1/11/84  1/11/84              1     0  54 FM-A
                                              1/12/84  1/12/84
```

```
Date:  9/ 4/84                 ************************************************                 Page   1
Project Id: HOUSE              *             House Construction               *        Last Acc:  9/ 4/84
                               *                 P R O M I S                  *        Last Upd:
                               ************************************************
Project start:  1/ 1/84                                                                Report #:  311-2
                                       MILESTONES REPORT - TARGET SCHEDULE


Selection: All
==========================================================================================
                    MILESTONE                                                  OVER
 ------------------------------------------------- EARLY     LATE     TARGET   EARLY    TOTAL
   ID    TYPE     DESCRIPTION                      SCHEDULE  SCHEDULE  DATE   SCHEDULE  FLOAT
==========================================================================================
  1000  START   START OF PROJECT                   1/ 2/84   1/ 2/84  1/ 1/84      0       0
  1010  START   start excavation                   1/ 3/84   1/ 3/84  1/19/84    -12       0
```

```
Date:  9/ 4/84                  ##########################################                 Page    1
Project Id: HOUSE               #             House Construction          #          Last Acc:  9/ 4/84
                                #                P R O M I S              #          Last Upd:
Project start:  1/ 1/84         ##########################################
                                                                                     Report #:  511-3
                                    DETAILED TIME ANALYSIS - TARGET SCHEDULE

Selection: ACT(1000-1030)
==================================================================================================================
           ACTIVITY                              EARLY/    EARLY/    PLANNED                      ACTIVITY CODES
------------------------------------    EST    LATE      LATE      START    TOTAL  FREE   ---------------------------
ID     DESCRIPTION                      DUR    START     FINISH             FLOAT  FLOAT  INC  RESP  AUX1  AUX2  AUX3
==================================================================================================================
1000 BEGIN CONSTRUCTION
                                          1    1/ 2/84   1/ 2/84               0      0    54  FH-B
                                               1/ 2/84   1/ 2/84
------------------------------------------------------------------------------------------------------------------

1010 EXCAVATE, POUR FOOTER
                                          4    1/ 3/84   1/ 6/84               0      0    54  FH-B
                                               1/ 3/84   1/ 6/84
    Prec Act ID  Lag Type  Lag
        1000       FS       0
                                          1    1/ 2/84   1/ 2/84               0      0    54  FH-B
                                               1/ 2/84   1/ 2/84

------------------------------------------------------------------------------------------------------------------

1020 POUR CONCRETE FOUNDATIONS
                                          2    1/ 9/84   1/10/84               0      0    54  FH-A
                                               1/ 9/84   1/10/84
    Prec Act ID  Lag Type  Lag
        1010       FS       0
                                          4    1/ 3/84   1/ 6/84               0      0    54  FH-B
                                               1/ 3/84   1/ 6/84

------------------------------------------------------------------------------------------------------------------

1030 ERECT FRAME AND ROOF
                                          4    1/11/84   1/16/84               0      0    54  FH-A
                                               1/11/84   1/16/84
    Prec Act ID  Lag Type  Lag
        1020       FS       0
                                          2    1/ 9/84   1/10/84               0      0    54  FH-A
                                               1/ 9/84   1/10/84
```

```
Date: 9/ 4/84                 ********************************************             Page   1
Project Id: HOUSE             *            House Construction            *        Last Acc: 9/ 4/84
                              *               P R O M I S                *        Last Upd:
                              ********************************************
Project start:  1/ 1/84                                                           Report #:  512-1
                                    RESOURCE REQUIREMENTS BY ACTIVITY

Selection: A-ID[1000-1060]
===================================================================================================
                    ACTIVITY                         RESOURCE           ST  UNITS     REQUIREMENTS          NO.
-------------------------------------------------  ---------------------  /   OF    -------------------------  OF
 ID        DESCRIPTION         RESP AUX1 AUX2 AUX3  ID    DESCRIPTION     OT MEASURE  FROM     TO   AMOUNT/DAY DAYS
===================================================================================================
1000 BEGIN CONSTRUCTION         FN-B               CLAB COMMON BUILDING LAB S    MHOUR  1/ 2/84  1/ 2/84   250.00   1

1010 EXCAVATE, POUR FOOTER      FN-B               BRHE BRICKLAYERS HELPERS S    MHOUR  1/ 3/84  1/ 6/84    25.00   4
                                                   CLAB COMMON BUILDING LAB O    MHOUR  1/ 3/84  1/ 6/84    70.00   4

1020 POUR CONCRETE FOUNDATIONS  FN-A               CLAB COMMON BUILDING LAB S    MHOUR  1/ 9/84  1/10/84   125.00   2

1030 ERECT FRAME AND ROOF       FN-A               CLAB COMMON BUILDING LAB S    MHOUR  1/11/84  1/16/84    90.00   4

1040 LAY BRICKWORK              FN-A               CLAB COMMON BUILDING LAB S    MHOUR  1/17/84  1/24/84    40.00   6

1050 INSTALL DRAINS             FN-A               CLAB COMMON BUILDING LAB S    MHOUR  1/11/84  1/11/84    50.00   1

1060 POUR BASEMENT FLOOR        FN-B               CLAB COMMON BUILDING LAB S    MHOUR  1/12/84  1/13/84   125.00   2
```

```
Date: 9/ 4/84                  ********************************************                Page   1
Project Id: HOUSE-2            *            House Construction            *          Last Acc: 9/ 4/84
                               *              P R O M I S                 *          Last Upd: 1/12/84
Project start: 1/ 1/84         ********************************************
                                                                                     Report #: 312-2
                                   RESOURCE REQUIREMENTS BY RESOURCE

Selection: CLAB
====================================================================================================
RESOURCE                                             REQUIREMENTS             NO.
   ID     DESCRIPTION          UNITS OF   ----------------------------------  OF                     CUMULATIVE
                               MEASURE    FROM       TO        AMOUNT/DAY    DAYS   REQUIREMENTS    REQUIREMENTS
====================================================================================================
 BRHE     BRICKLAYERS HELPERS  MHOUR      1/ 3/84    1/ 6/84     25.00        4        100.00          100.00
                                                                ---------------------------
                                                                 TOTAL:      4        100.00

 CLAB     COMMON BUILDING LAB  MHOUR      1/ 2/84    1/ 2/84    250.00        1        250.00          250.00
                                          1/ 3/84    1/ 6/84     70.00        4        280.00          530.00
                                          1/ 9/84    1/10/84    125.00        2        250.00          780.00
                                          1/11/84    1/11/84    140.00        1        140.00          920.00
                                          1/12/84    1/13/84    305.00        2        610.00         1530.00
                                          1/16/84    1/16/84    180.00        1        180.00         1710.00
                                          1/17/84    1/20/84     40.00        4        160.00         1870.00
                                          1/23/84    1/24/84     40.00        2         80.00         1950.00
                                                                ---------------------------
                                                                 TOTAL:     17       1950.00
```

```
Date:  9/ 4/84                 ******************************************                 Page   1
Project Id: HOUSE              *           House Construction           *           Last Acc:  9/ 4/84
                               *               P R O M I S              *           Last Upd:
                               ******************************************
Project start:  1/ 1/84                                                             Report #:  312-3
                                          EXCESS RESOURCE REQUIREMENTS

Selection: All
================================================================================================================
        RESOURCE            UNIT          REQUIREMENTS            NO.
----------------------------  OF    ---------------------------- OF                         EXCESS        CUMULATIVE
                                                                                   DAILY  REQUIREMENTS    EXCESS
  ID     DESCRIPTION       MEASURE    FROM      TO    AMOUNT/DAY DAYS REQUIREMENTS AVAIL.   PER DAY     REQUIREMENTS
================================================================================================================
BRHE  BRICKLAYERS HELPERS  MHOUR    1/ 3/84   1/ 6/84     25.00    4      100.00     0.00     25.00        100.00
                                                      ---------------------------------------------------------
                                                      TOTALS:     4      100.00                              100.00

CLAB  COMMON BUILDING LAB  MHOUR    1/ 2/84   1/ 2/84    250.00    1      250.00     0.00    250.00        250.00
                                    1/ 3/84   1/ 6/84     70.00    4      280.00     0.00     70.00        530.00
                                    1/ 9/84   1/10/84    125.00    2      250.00     0.00    125.00        780.00
                                    1/11/84   1/11/84    140.00    1      140.00     0.00    140.00        920.00
                                    1/12/84   1/13/84    305.00    2      610.00     0.00    305.00       1530.00
                                    1/16/84   1/16/84    180.00    1      180.00     0.00    180.00       1710.00
                                    1/17/84   1/20/84     40.00    4      160.00     0.00     40.00       1870.00
                                    1/23/84   1/24/84     40.00    2       80.00     0.00     40.00       1950.00
                                                      ---------------------------------------------------------
                                                      TOTALS:    17     1950.00                             1950.00
```

```
Date: 5/ 4/84                 ##########################################                    Page   1
Project Id: HOUSE             #           House Construction           #           Last Acc: 5/ 4/84
                              #              P R O M I S               #           Last Upd:
                              ##########################################
Project start: 1/ 1/84                                                             Report #: 313-1
                         SUMMARY COST ESTIMATES BY ACTIVITY (TARGET SCHEDULE)

Selection: A-ID(1000-1060)
=====================================================================================================
              ACTIVITY                                         O.H.                     O.H.
---------------------------------------------- EST  RESOURCE    &         FIXED          &      ACTIVITY
ID      DESCRIPTION          RESP AUX1 AUX2 AUX3 DUR   COSTS     PROFIT      COSTS       PROFIT    COSTS
=====================================================================================================
1000 BEGIN CONSTRUCTION       FH-B                1    2787.50    836.25      0.00        0.00    3623.75
1010 EXCAVATE, POUR FOOTER    FH-B                4    5835.00   1544.40      0.00        0.00    7379.40
1020 POUR CONCRETE FOUNDATIONS FH-A               2    2787.50    836.25      0.00        0.00    3623.75
1030 ERECT FRAME AND ROOF     FH-A                4    4014.00    923.22      0.00        0.00    4937.22
1040 LAY BRICKWORK            FH-A                6    2676.00    669.00      0.00        0.00    3345.00
1050 INSTALL DRAINS           FH-A                1     557.50    139.37      0.00        0.00     696.87
1060 POUR BASEMENT FLOOR      FH-B                2    2787.50    836.25      0.00        0.00    3623.75
-----------------------------------------------------------------------------------------------------
     TOTAL :                                          24455.50   6537.37      0.00        0.00   27229.74
```

```
Date:  9/ 4/84                       ********************************************                Page   1
Project Id: HOUSE                    *            House Construction            *          Last Acc:  9/ 4/84
                                     *               P R O M I S                *          Last Upd:
Project start:  1/ 1/84              ********************************************
                                                                                           Report #:  513-2
                                   DETAILED COST ESTIMATES BY ACTIVITY (TARGET SCHEDULE)

Selections: A-ID[1000-1040]
=================================================================================================================
                  ACTIVITY                                 RESOURCE  COST                FIXED  COST          TOTAL
------------------------------------------------ EST  ------------------------  -------------------------  ACTIVITY
 ID        DESCRIPTION          RESP AUX1 AUX2 AUX3 DUR  ID    AMOUNT   OH & PROFIT  ID   AMOUNT   OH & PROFIT   COSTS
=================================================================================================================
1000 BEGIN CONSTRUCTION         FN-B                   1  CLAB  2787.50     836.25
                                                    -------------------------------------------------------------
                                                    TOTAL :     2787.50     836.25           0.00       0.00   3623.75

1010 EXCAVATE, POUR FOOTER      FN-B                   4  BHOE  1145.00     137.40
                                                          CLAB  4690.00    1407.00
                                                    -------------------------------------------------------------
                                                    TOTAL :     5835.00    1544.40           0.00       0.00   7379.40

1020 POUR CONCRETE FOUNDATIONS  FN-A                   2  CLAB  2787.50     836.25
                                                    -------------------------------------------------------------
                                                    TOTAL :     2787.50     836.25           0.00       0.00   3623.75

1030 ERECT FRAME AND ROOF       FN-A                   4  CLAB  4014.00     923.22
                                                    -------------------------------------------------------------
                                                    TOTAL :     4014.00     923.22           0.00       0.00   4937.22

1040 LAY BRICKWORK              FN-A                   6  CLAB  2676.00     669.00
                                                    -------------------------------------------------------------
                                                    TOTAL :     2676.00     669.00           0.00       0.00   3345.00


    =============================================================================================================
          TOTAL :                                              18100.00    4809.12           0.00       0.00  22909.12
```

```
Date:  9/ 4/84                   $$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$                    Page    1
Project Id: HOUSE                $            House Construction            $              Last Acc:  9/ 4/84
                                 $               P R O M I S                $              Last Upd:
                                 $$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$
Project start:  1/ 1/84                                                                    Report #:  513-3
                                     RESOURCE COSTING REPORT - TARGET SCHEDULE

Selection: All
==================================================================================================================
                                                     REQUIREMENTS                  NO.
RESOURCE                            UNITS OF   ----------------------------------  OF                    CUMULATIVE
   ID        DESCRIPTION            MEASURE      FROM        TO        COST/DAY    DAYS       COST          COST
==================================================================================================================
BRHE         BRICKLAYERS HELPERS    MHOUR       1/ 3/84     1/ 6/84      286.25      4       1145.00       1145.00
                                                                       --------------------------------
                                                                         TOTAL:      4       1145.00

CLAB         COMMON BUILDING LAB    MHOUR       1/ 2/84     1/ 2/84     2787.50      1       2787.50       2787.50
                                                1/ 3/84     1/ 6/84     1172.50      4       4690.00       7477.50
                                                1/ 9/84     1/10/84     1393.75      2       2787.50      10265.00
                                                1/11/84     1/11/84     1561.00      1       1561.00      11826.00
                                                1/12/84     1/13/84     3400.75      2       6801.50      18627.50
                                                1/16/84     1/16/84     2007.00      1       2007.00      20634.50
                                                1/17/84     1/20/84      446.00      4       1784.00      22418.50
                                                1/23/84     1/24/84      446.00      2        892.00      23310.50
                                                                       --------------------------------
                                                                         TOTAL:     17      23310.50
```

```
Date: 11/21/84        ************************************          Page    1
Project Id: TUTOR2    *      Project Management System      * Last Acc: 11/15/84
                      *             P R O M I S             * Last Upd:  1/16/84
                      ************************************
Project start:  1/ 2/84                                     Report #:  513-4
                       BASELINE CASHFLOW - EARLY SCHEDULE

Selection: All         DAILY
================================================================================
  FROM      TO       # OF DAYS            CASHFLOW          CUMULATIVE CASHFLOW
================================================================================
 1/ 2/84  1/ 2/84        1                  358.00                    358.00
 1/ 3/84  1/ 3/84        1                  358.00                    716.00
 1/ 4/84  1/ 4/84        1                  358.00                   1074.00
 1/ 5/84  1/ 5/84        1                  358.00                   1432.00
 1/ 6/84  1/ 6/84        1                  358.00                   1790.00
 1/ 7/84  1/ 7/84        1                    0.00                   1790.00
 1/ 8/84  1/ 8/84        1                    0.00                   1790.00
 1/ 9/84  1/ 9/84        1                 5015.00                   6805.00
 1/10/84  1/10/84        1                 5015.00                  11820.00
 1/11/84  1/11/84        1                 3440.00                  15260.00
 1/12/84  1/12/84        1                    0.00                  15260.00
 1/13/84  1/13/84        1                    0.00                  15260.00
 1/14/84  1/14/84        1                    0.00                  15260.00
 1/15/84  1/15/84        1                    0.00                  15260.00
 1/16/84  1/16/84        1                    0.00                  15260.00
 1/17/84  1/17/84        1                    0.00                  15260.00
 1/18/84  1/18/84        1                    0.00                  15260.00
 1/19/84  1/19/84        1                  510.00                  15770.00
 1/20/84  1/20/84        1                  480.00                  16250.00
 1/21/84  1/21/84        1                    0.00                  16250.00
 1/22/84  1/22/84        1                    0.00                  16250.00
 1/23/84  1/23/84        1                  480.00                  16730.00
 1/24/84  1/24/84        1                  480.00                  17210.00
 1/25/84  1/25/84        1                  480.00                  17690.00
 1/26/84  1/26/84        1                    0.00                  17690.00
```

```
Date: 11/21/84        *************************************          Page    1
Project Id: TUTOR2    *      Project Management System       * Last Acc: 11/15/84
                      *             P R O M I S              * Last Upd:  1/16/84
                      *************************************
Project start:  1/ 2/84                                       Report #:  513-4
                        BASELINE CASHFLOW - EARLY SCHEDULE

Selection: All          WEEKLY
================================================================================
 FROM      TO         # OF DAYS             CASHFLOW          CUMULATIVE CASHFLOW
================================================================================
 1/ 2/84  1/ 8/84         7                 1790.00                      1790.00
 1/ 9/84  1/15/84         7                13470.00                     15260.00
 1/16/84  1/22/84         7                  990.00                     16250.00
 1/23/84  1/29/84         7                 1440.00                     17690.00
```

```
Date: 11/21/84        ************************************           Page    1
Project Id: TUTOR2    *      Project Management System     * Last Acc: 11/15/84
                      *              P R O M I S           * Last Upd:  1/16/84
                      ************************************
Project start:  1/ 2/84                                     Report #:  513-4
                        BASELINE CASHFLOW - EARLY SCHEDULE

Selection: All          MONTHLY
==============================================================================
  FROM      TO          # OF DAYS              CASHFLOW          CUMULATIVE CASHFLOW
==============================================================================
 1/ 1/84  1/31/84         31                   17690.00                   17690.00
```

```
Date: 3/ 4/84                    ******************************************
Project Id: HOUSE-2              *           House Construction           *         Page    1
                                 *              P R O M I S               *    Last Acc: 3/ 4/84
Project start: 1/ 1/84           ******************************************    Last Upd: 1/12/84

                                     TIME ANALYSIS - PROGRESS TO DATE          Report #: 521-1

Selection: ACT(1000-1040)

*********************************************************************************Data Date : 1/12/84
            ACTIVITY                  DUR  EARLY/   EARLY/    PLANNED  ACTUAL   % COMP  TOTAL/        ACTIVITY CODES
--------------------------------------EST/ LATE     LATE      START    START/     /     FREE    ------------------------
ID   SUBPROJ  DESCRIPTION             ACT  START    FINISH             FINISH  REM DUR  FLOAT   WBC RESP AUX1 AUX2 AUX3
***************************************************************************************************************************
1000          BEGIN CONSTRUCTION
                                       1   1/ 2/84  1/ 2/84            1/ 2/84  100.00   N/A    5d FN-B
                                       1   1/ 2/84  1/ 2/84            1/ 2/84       0   N/A

1010          EXCAVATE, POUR FOOTER
                                       4   1/ 3/84  1/ 6/84            1/ 3/84  100.00   N/A    5d FN-B
                                       4   1/ 3/84  1/ 6/84            1/ 6/84       0   N/A

1020          POUR CONCRETE FOUNDATIONS
                                       2   1/ 9/84  1/10/84            1/ 9/84  100.00   N/A    5d FN-A
                                       2   1/ 9/84  1/10/84            1/10/84       0   N/A

1030          ERECT FRAME AND ROOF
                                       4   1/11/84  1/16/84            1/11/84   50.00     0    5d FN-A
                                       4   1/11/84  1/16/84                          2     0

1040          LAY BRICKWORK
                                       6   1/17/84  1/24/84                       0.00     0    5d FN-A
                                           1/27/84  2/ 3/84                          6     0
```

```
Date:  9/ 4/84                 *****************************************                 Page    1
Project Id: HOUSE-2            *           House Construction          *          Last Acc:  9/ 4/84
                               *               P R O M I S             *          Last Upd:  1/12/84
                               *****************************************
Project start:  1/ 1/84                                                            Report #:  521-2
                                    MILESTONES REPORT - PROGRESS TO DATE

Selection: All
                                                                        Data Date :  1/12/84
==========================================================================================
                MILESTONE                                                        OVER
 ---------------------------------------     EARLY     LATE     TARGET   ACTUAL   ACTUAL   TOTAL
   ID   TYPE    DESCRIPTION                SCHEDULE  SCHEDULE    DATE     DATE   SCHEDULE  FLOAT
==========================================================================================
  1000  START   START OF PROJECT            1/ 2/84   1/ 2/84   1/ 1/84  1/ 2/84     0      N/A
  1010  START   start excavation            1/ 3/84   1/ 3/84   1/ 3/84  1/ 3/84     0      N/A
```

```
Date:  9/ 4/84                   ******************************************                 Page    1
Project Id: HOUSE-2              *            House Construction          *          Last Acc:  9/ 4/84
                                 *              P R O M I S               *          Last Upd:  1/12/84
                                 ******************************************
Project start:  1/ 1/84                                                              Report #:  521-3
                                     DETAILED TIME ANALYSIS - PROGRESS TO DATE


Selection: ACT[1000-1030]
                                                                                     Data Date :  1/12/84
==========================================================================================================
            ACTIVITY                DUR  EARLY/   EARLY/   PLANNED  ACTUAL   % COMP  TOTAL/      ACTIVITY CODES
----------------------------------- EST/ LATE     LATE     START    START/     /     FREE   ----------------------------
ID    DESCRIPTION                   ACT  START    FINISH            FINISH   REM DUR FLOAT WBC  RESP  AUX1  AUX2  AUX3
==========================================================================================================
1000 BEGIN CONSTRUCTION              1   1/ 2/84  1/ 2/84           1/ 2/84  100.00   N/A   5d  FN-B
                                     1   1/ 2/84  1/ 2/84           1/ 2/84       0   N/A
----------------------------------------------------------------------------------------------------------

1010 EXCAVATE, POUR FOOTER           4   1/ 3/84  1/ 6/84           1/ 3/84  100.00   N/A   5d  FN-B
                                     4   1/ 3/84  1/ 6/84           1/ 6/84       0   N/A
     Prec Act ID  Lag Type  Lag
         1000        FS       0      1   1/ 2/84  1/ 2/84           1/ 2/84  100.00   N/A   5d  FN-B
                                     1   1/ 2/84  1/ 2/84           1/ 2/84       0   N/A

----------------------------------------------------------------------------------------------------------

1020 POUR CONCRETE FOUNDATIONS       2   1/ 9/84  1/10/84           1/ 9/84  100.00   N/A   5d  FN-A
                                     2   1/ 9/84  1/10/84           1/10/84       0   N/A
     Prec Act ID  Lag Type  Lag
         1010        FS       0      4   1/ 3/84  1/ 6/84           1/ 3/84  100.00   N/A   5d  FN-B
                                     4   1/ 3/84  1/ 6/84           1/ 6/84       0   N/A

----------------------------------------------------------------------------------------------------------

1030 ERECT FRAME AND ROOF            4   1/11/84  1/16/84           1/11/84   50.00     0   5d  FN-A
                                     4   1/11/84  1/16/84                         2     0
     Prec Act ID  Lag Type  Lag
         1020        FS       0      2   1/ 9/84  1/10/84           1/ 9/84  100.00   N/A   5d  FN-A
                                     2   1/ 9/84  1/10/84           1/10/84       0   N/A
```

```
Date:  9/ 4/84                 ********************************************                Page   1
Project Id: HOUSE-2            *              House Construction           *           Last Acc:  9/ 4/84
                               *               P R O M I S                 *           Last Upd:  1/12/84
                               ********************************************
Project start:  1/ 1/84                                                                Report #:  522-1
                                       RESOURCE USAGE BY ACTIVITY

Selection: All
                                                                                       Data Date :  1/12/84
=====================================================================================================================
                    ACTIVITY                                 RESOURCE          ST   UNITS           USAGE              NO.
 ------------------------------------------------- ------------------------   /     OF    ---------------------------  OF
 ID         DESCRIPTION             RESP AUX1 AUX2 AUX3  ID      DESCRIPTION   OT  MEASURE   FROM      TO   AMOUNT/DAY DAYS
=====================================================================================================================
1000 BEGIN CONSTRUCTION             FM-B                CLAB COMMON BUILDING LAB S     MHOUR  1/ 2/84  1/ 2/84    16.00    1

1010 EICAVATE, POUR FOOTER          FM-B                BRHE BRICKLAYERS HELPERS S     MHOUR  1/ 3/84  1/ 3/84   100.00    1
                                                        CLAB COMMON BUILDING LAB O     MHOUR  1/ 3/84  1/ 3/84   200.00    1

1020 POUR CONCRETE FOUNDATIONS      FM-A                CLAB COMMON BUILDING LAB S     MHOUR  1/ 9/84  1/ 9/84   250.00    1

1030 ERECT FRAME AND ROOF           FM-A                CLAB COMMON BUILDING LAB S     MHOUR  1/11/84  1/12/84    90.00    2

1040 LAY BRICKWORK                  FM-A                CLAB COMMON BUILDING LAB S     MHOUR

1050 INSTALL DRAINS                 FM-A                CLAB COMMON BUILDING LAB S     MHOUR  1/11/84  1/11/84    50.00    1

1060 POUR BASEMENT FLOOR            FM-B                CLAB COMMON BUILDING LAB S     MHOUR  1/12/84  1/12/84   120.00    1

1070 INSTALL ROUGH PLUMBING         FM-A                CLAB COMMON BUILDING LAB S     MHOUR  1/12/84  1/12/84    90.00    1
```

```
Date:  9/ 4/84                  ******************************************                  Page    1
Project Id: HOUSE-2             *            House Construction          *          Last Acc:  9/ 4/84
                                *               P R O M I S              *          Last Upd:  1/12/84
Project start:  1/ 1/84         ******************************************
                                                                                    Report #:  522-2
                                          RESOURCE USAGE BY RESOURCE

Selections: All
******************************************************************************************************
          RESOURCE                UNIT              RESOURCE USAGE            NO.
--------------------------------   OF      ------------------------------    OF                CUMULATIVE
  ID         DESCRIPTION         MEASURE    FROM       TO      AMOUNT/DAY   DAYS      USAGE       USAGE
******************************************************************************************************
BRHE      BRICKLAYERS HELPERS    MHOUR     1/ 3/84    1/ 3/84    100.00       1       100.00      100.00

CLAB      COMMON BUILDING LAB    MHOUR     1/ 2/84    1/ 2/84     16.00       1        16.00       16.00
                                           1/ 3/84    1/ 3/84    280.00       1       280.00      296.00
                                           1/ 9/84    1/ 9/84    250.00       1       250.00      546.00
                                           1/11/84    1/11/84    140.00       1       140.00      686.00
                                           1/12/84    1/12/84    300.00       1       300.00      986.00
                                                                ----------------------------
                                                                 TOTAL:       5       986.00
```

```
Date:  9/ 4/84                  *********************************************                Page   1
Project Id: HOUSE-2             *              House Construction            *         Last Acc:  9/ 4/84
                                *                 P R O M I S                *         Last Upd:  1/12/84
                                *********************************************
Project start:  1/ 1/84                                                               Report #:  322-3
                                      EXCESS RESOURCE USAGE BY RESOURCE


Selection: All
=====================================================================================================================
        RESOURCE               UNIT           RESOURCE USAGE          NO.                         EXCESS  CUMULATIVE
----------------------------    OF     ----------------------------   OF                 DAILY     USAGE     EXCESS
 ID       DESCRIPTION         MEASURE   FROM      TO     AMOUNT/DAY  DAYS      USAGE     AVAIL.   PER DAY    USAGE
=====================================================================================================================
BRHE  BRICKLAYERS HELPERS     MHOUR    1/ 3/84  1/ 3/84    100.00      1      100.00      0.00     100.00    100.00

CLAB  COMMON BUILDING LAB     MHOUR    1/ 2/84  1/ 2/84     16.00      1       16.00      0.00      16.00     16.00
                                       1/ 3/84  1/ 3/84    280.00      1      280.00      0.00     280.00    296.00
                                       1/ 9/84  1/ 9/84    250.00      1      250.00      0.00     250.00    546.00
                                       1/11/84  1/11/84    140.00      1      140.00      0.00     140.00    686.00
                                       1/12/84  1/12/84    300.00      1      300.00      0.00     300.00    986.00
                                                         ----------------------------
                                                           TOTALS:     5      986.00
```

```
Date: 9/ 4/84                 ********************************************                Page   1
Project Id: HOUSE-2           *           House Construction             *           Last Acc: 9/ 4/84
                              *               P R O M I S                *           Last Upd: 1/12/84
                              ********************************************
Project start: 1/ 1/84                                                               Report #: 323-1
                             SUMMARY COST ESTIMATES BY ACTIVITY (ACTUAL SCHEDULE)

Selection: All
                                                                                     Data Date : 1/12/84
******************************************************************************************************
                                                                     ACTUAL                   PLANNED
                    ACTIVITY                               ---------------------------------- ---------
-------------------------------------------------- EST  %   TOTAL   USED    REMAINING   TOTAL      TOTAL
ID       DESCRIPTION          RESP AUX1 AUX2 AUX3 DUR COMP. FLOAT RESOURCE / RESOURCE / RESOURCE / RESOURCE /
                                                               FIXED COSTS FIXED COSTS FIXED COSTS FIXED COSTS
******************************************************************************************************
1000 BEGIN CONSTRUCTION       FM-B                  1 100.00 N/A    178.40       0.00     178.40    2787.50
                                                                      0.00       0.00       0.00       0.00
                                                         ----------------------------------------------
                                                         TOTAL :    178.40       0.00     178.40    2787.50


1010 EXCAVATE, POUR FOOTER    FM-B                  4 100.00 N/A   5835.00       0.00    5835.00    5835.00
                                                                      0.00    2500.00    2500.00    2500.00
                                                         ----------------------------------------------
                                                         TOTAL :   5835.00    2500.00    8335.00    8335.00


1020 POUR CONCRETE FOUNDATIONS FM-A                 2 100.00 N/A   2787.50       0.00    2787.50    2787.50
                                                                      0.00    4600.00    4600.00    4600.00
                                                         ----------------------------------------------
                                                         TOTAL :   2787.50    4600.00    7387.50    7387.50


1030 ERECT FRAME AND ROOF     FM-A                  4  50.00    0  2007.00    2007.00    4014.00    4014.00
                                                                      0.00    2000.00    2000.00    2000.00
                                                         ----------------------------------------------
                                                         TOTAL :   2007.00    4007.00    6014.00    6014.00


1040 LAY BRICKWORK            FM-A                  6   0.00    8     0.00    2676.00    2676.00    2676.00
                                                                      0.00    5000.00    5000.00    5000.00
                                                         ----------------------------------------------
                                                         TOTAL :      0.00    7676.00    7676.00    7676.00


1050 INSTALL DRAINS           FM-A                  1 100.00 N/A    557.50       0.00     557.50     557.50
                                                                      0.00     650.00     650.00     650.00
                                                         ----------------------------------------------
                                                         TOTAL :    557.50     650.00    1207.50    1207.50


1060 POUR BASEMENT FLOOR      FM-B                  2  50.00    1  1338.00    1449.50    2787.50    2787.50
                                                                      0.00    1500.00    1500.00    1500.00
                                                         ----------------------------------------------
                                                         TOTAL :   1338.00    2949.50    4287.50    4287.50


1070 INSTALL ROUGH PLUMBING   FM-A                  3  33.33    4  1003.50    2007.00    3010.50    3010.50
                                                                      0.00     700.00     700.00     700.00
                                                         ----------------------------------------------
                                                         TOTAL :   1003.50    2707.00    3710.50    3710.50
```

```
Date: 9/ 4/84                  ********************************************
Project Id: HOUSE-2            *            House Construction            *          Page   1
                               *               P R O M I S                *      Last Acc:  9/ 4/84
                               ********************************************      Last Upd:  1/12/84
Project start:  1/ 1/84
                               DETAILED COST ESTIMATES BY ACTIVITY (ACTUAL SCHEDULE)    Report #:  523-2

Selection: A-ID[1000-1030]

                                                                                  Data Date :  1/12/84
=======================================================================================================
                 ACTIVITY
------------------------------------------------------------ ESTIMATED  PERCENT   TOTAL
 ID        DESCRIPTION               RESP  AUI1  AUI2  AUI3  DURATION   COMPLETE  FLOAT
=======================================================================================================
1000  BEGIN CONSTRUCTION             FN-B                        1       100.00    N/A

                RESOURCE  COSTS                                       FIXED  COSTS               ACTIVITY
       ---------------------------------------------  -------------------------------------------  COSTS
            ACTUAL    ACTUAL       ACTUAL    PLANNED           ACTUAL    ACTUAL     ACTUAL   PLANNED  ACTUAL/
       ID    USED     REMAINING    TOTAL     TOTAL      ID      USED     REMAINING  TOTAL    TOTAL    PLANNED
       ------------------------------------------------------------------------------------------------
       CLAB  170.40      0.00      170.40    2787.50
       ------------------------------------------------------------------------------------------------
       TOTAL :                     170.40    2787.50  TOTAL :                        0.00      0.00    170.40
                                                                                                   2787.50
       ------------------------------------------------------------------------------------------------

1010  EXCAVATE, POUR FOOTER          FN-B                        4       100.00    N/A

                RESOURCE  COSTS                                       FIXED  COSTS               ACTIVITY
       ---------------------------------------------  -------------------------------------------  COSTS
            ACTUAL    ACTUAL       ACTUAL    PLANNED           ACTUAL    ACTUAL     ACTUAL   PLANNED  ACTUAL/
       ID    USED     REMAINING    TOTAL     TOTAL      ID      USED     REMAINING  TOTAL    TOTAL    PLANNED
       ------------------------------------------------------------------------------------------------
       BRNE 1145.00      0.00     1145.00    1145.00  C100      0.00    1000.00    1000.00  1000.00
       CLAB 4690.00      0.00     4690.00    4690.00  C101      0.00    1500.00    1500.00  1500.00
       ------------------------------------------------------------------------------------------------
       TOTAL :                    5835.00    5835.00  TOTAL :                     2500.00   2500.00   8335.00
                                                                                                   8335.00
       ------------------------------------------------------------------------------------------------

1020  POUR CONCRETE FOUNDATIONS      FN-A                        2       100.00    N/A

                RESOURCE  COSTS                                       FIXED  COSTS               ACTIVITY
       ---------------------------------------------  -------------------------------------------  COSTS
            ACTUAL    ACTUAL       ACTUAL    PLANNED           ACTUAL    ACTUAL     ACTUAL   PLANNED  ACTUAL/
       ID    USED     REMAINING    TOTAL     TOTAL      ID      USED     REMAINING  TOTAL    TOTAL    PLANNED
       ------------------------------------------------------------------------------------------------
       CLAB 2787.50      0.00     2787.50    2787.50  C102      0.00    2700.00    2700.00  2700.00
                                                      C103      0.00    1900.00    1900.00  1900.00
       ------------------------------------------------------------------------------------------------
       TOTAL :                    2787.50    2787.50  TOTAL :                     4600.00   4600.00   7387.50
                                                                                                   7387.50
       ------------------------------------------------------------------------------------------------

1030  ERECT FRAME AND ROOF           FN-A                        4        50.00    0
```

```
Date: 9/ 4/84                   ********************************************                 Page    1
Project Id: HOUSE-2             *            House Construction            *            Last Acc:  9/ 4/84
                                *               P R O M I S                *            Last Upd:  1/12/84
                                ********************************************
Project start:  1/ 1/84                                                                Report #:  523-3
                                    RESOURCE COSTING REPORT - ACTUAL COSTS


Selection: All
======================================================================================================
                                                         RESOURCE USAGE            NO.
RESOURCE                          UNITS OF      ------------------------------     OF              CUMULATIVE
   ID        DESCRIPTION          MEASURE       FROM        TO        COST/DAY    DAYS    COST        COST
======================================================================================================
 BRHE        BRICKLAYERS HELPERS  MHOUR        1/ 3/84    1/ 3/84     1145.00       1    1145.00     1145.00
                                                                    ---------------------------
                                                                      TOTAL:        1    1145.00

 CLAB        COMMON BUILDING LAB  MHOUR        1/ 2/84    1/ 2/84      178.40       1     178.40      178.40
                                               1/ 3/84    1/ 3/84     4690.00       1    4690.00     4868.40
                                               1/ 9/84    1/ 9/84     2787.50       1    2787.50     7655.90
                                               1/11/84    1/11/84     1561.00       1    1561.00     9216.90
                                               1/12/84    1/12/84     3345.00       1    3345.00    12561.90
                                                                    ---------------------------
                                                                      TOTAL:        5   12561.90
```

```
Date:  9/ 4/84        ****************************************           Page    1
Project Id: HOUSE-2  *          House Construction           * Last Acc:  9/ 4/84
                     *              P R O M I S               * Last Upd:  1/12/84
                      ****************************************
Project start:  1/ 1/84                                       Report #:  523-4
                         ACTUAL CASHFLOW - EARLY SCHEDULE


Selection: All          DAILY
================================================================================
  FROM       TO        # OF DAYS               CASHFLOW          CUMULATIVE CASHFLOW
================================================================================
 1/ 2/84  1/ 2/84          1                     178.40                    178.40
 1/ 3/84  1/ 3/84          1                    6460.00                   6638.40
 1/ 4/84  1/ 4/84          1                     625.00                   7263.40
 1/ 5/84  1/ 5/84          1                     625.00                   7888.40
 1/ 6/84  1/ 6/84          1                     625.00                   8513.40
 1/ 7/84  1/ 7/84          1                       0.00                   8513.40
 1/ 8/84  1/ 8/84          1                       0.00                   3513.40
 1/ 9/84  1/ 9/84          1                    5087.50                  13600.90
 1/10/84  1/10/84          1                    2300.00                  15900.90
 1/11/84  1/11/84          1                    2211.00                  18111.90
 1/12/84  1/12/84          1                    3345.00                  21456.90
 1/13/84  1/13/84          1                    6306.50                  27763.40
 1/14/84  1/14/84          1                       0.00                  27763.40
 1/15/84  1/15/84          1                       0.00                  27763.40
 1/16/84  1/16/84          1                    3357.00                  31120.40
 1/17/84  1/17/84          1                    1279.33                  32399.73
 1/18/84  1/18/84          1                    1279.33                  33679.06
 1/19/84  1/19/84          1                    1279.33                  34958.39
 1/20/84  1/20/84          1                    1279.33                  36237.73
 1/21/84  1/21/84          1                       0.00                  36237.73
 1/22/84  1/22/84          1                       0.00                  36237.73
 1/23/84  1/23/84          1                    1279.33                  37517.06
 1/24/84  1/24/84          1                    1279.33                  38796.39
 1/25/84  1/25/84          1                       0.00                  38796.39
```

```
Date:  9/ 4/84      ************************************        Page    1
Project Id: HOUSE-2 *          House Construction          * Last Acc:  9/ 4/84
                    *              P R O M I S             * Last Upd:  1/12/84
                    ************************************
Project start:  1/ 1/84                                    Report #:  523-4
                         ACTUAL CASHFLOW - EARLY SCHEDULE

Selection: All        WEEKLY
===========================================================================
 FROM       TO       # OF DAYS            CASHFLOW         CUMULATIVE CASHFLOW
===========================================================================
 1/ 2/84  1/ 8/84        7                  8513.40                   8513.40
 1/ 9/84  1/15/84        7                 19250.00                  27763.40
 1/16/84  1/22/84        7                  8474.33                  36237.73
 1/23/84  1/29/84        7                  2558.66                  38796.39
```

```
Date:  9/ 4/84       ***************************************          Page    1
Project Id: HOUSE-2  *          House Construction          * Last Acc:  9/ 4/84
                     *             P R O M I S              * Last Upd:  1/12/84
                     ***************************************
Project start:  1/ 1/84                                      Report #:  523-4
                       ACTUAL CASHFLOW - EARLY SCHEDULE

Selection: All       MONTHLY
==============================================================================
  FROM     TO        # OF DAYS              CASHFLOW        CUMULATIVE CASHFLOW
==============================================================================
 1/ 1/84  1/31/84       31                  38796.39                   38796.39
```

```
Date:  5/ 4/84                  ########################################              Page    1
Project Id: HOUSE-2             #           House Construction         #         Last Acc:  5/ 4/84
                                #              P R O M I S             #         Last Upd:  1/12/84
                                ########################################
Project start:  1/ 1/84                                                          Report #:  523-5
                                   EARNED VALUE ANALYSIS BY ACTIVITY


Selections: All

                                                                                 Data Date :  1/12/84
###################################################################################################################
ACT.    ACTIVITY DESCRIPTION             CUMULATIVE TO DATE               VARIANCE             FORECAST TO COMPLETE
ID                                -----------------------------------  ------------------  --------------------------------
                                      BCWS        BCWP        ACWP     SCHEDULE  COST        BUDGET  REVISED EST.  VARIANCE
###################################################################################################################
1000 BEGIN CONSTRUCTION              2787.50     2787.50      178.40       0    -2609.10       0.00       0.00       0.00
1010 EXCAVATE, POUR FOOTER           8335.00     8335.00     5835.00       0    -2500.00       0.00       0.00       0.00
1020 POUR CONCRETE FOUNDATIONS       7307.50     7307.50     2707.50       0    -4600.00       0.00       0.00       0.00
1030 ERECT FRAME AND ROOF            3007.00     3007.00     2007.00       0    -1000.00    3007.00    4007.00    1000.00
1040 LAY BRICKWORK                      0.00        0.00        0.00       0        0.00    7676.00    7676.00       0.00
1050 INSTALL DRAINS                  1207.50     1207.50      557.50       0     -650.00       0.00       0.00       0.00
1060 POUR BASEMENT FLOOR             2143.75     2143.75     1338.00       0     -805.75    2143.75    2949.50     805.75
1070 INSTALL ROUGH PLUMBING          1236.70     1236.70     1003.50       0     -233.20    2473.75    2707.00     233.20
1080 INSTALL ROUGH WIRING               0.00        0.00        0.00       0        0.00       0.00       0.00       0.00
1090 INSTALL AIR CONDITIONING           0.00        0.00        0.00       0        0.00       0.00       0.00       0.00
1100 FASTEN PLASTER, PLASTER BOARD      0.00        0.00        0.00       0        0.00       0.00       0.00       0.00
1110 LAY FINISHED FLOORING              0.00        0.00        0.00       0        0.00       0.00       0.00       0.00
1120 INSTALL KITCHEN EQUIPMENT          0.00        0.00        0.00       0        0.00       0.00       0.00       0.00
1130 INSTALL FINISHED PLUMBING          0.00        0.00        0.00       0        0.00       0.00       0.00       0.00
1140 FINISH CARPENTRY                   0.00        0.00        0.00       0        0.00       0.00       0.00       0.00
1150 FINISH ROOFING AND FLASHING        0.00        0.00        0.00       0        0.00       0.00       0.00       0.00
1160 FASTEN GUTTERS AND DOWNSPOUTS      0.00        0.00        0.00       0        0.00       0.00       0.00       0.00
1170 LAY STORM DRAINS                   0.00        0.00        0.00       0        0.00       0.00       0.00       0.00
1180 SAND AND VARNISH FLOORS            0.00        0.00        0.00       0        0.00       0.00       0.00       0.00
1190 PAINT                              0.00        0.00        0.00       0        0.00       0.00       0.00       0.00
1200 FINISH ELECTRICAL WORK             0.00        0.00        0.00       0        0.00       0.00       0.00       0.00
1210 FINISH GRADING                     0.00        0.00        0.00       0        0.00       0.00       0.00       0.00
1220 POUR WALKS, AND LANDSCAPE          0.00        0.00        0.00       0        0.00       0.00       0.00       0.00
9000 FINISH BUILDING THE HOUSE          0.00        0.00        0.00       0        0.00       0.00       0.00       0.00

                                  -----------------------------------  ------------------  --------------------------------

TOTALS:                             26104.95    26104.95    13706.90            -12398.05   15300.54   17339.50    2038.95
```

```
Date:  9/ 4/84                   ************************************************                  Page    1
Project Id: HOUSE-2              *              House Construction              *            Last Acc:  9/ 4/84
                                 *                 P R O M I S                  *            Last Upd:  1/12/84
                                 ************************************************
Project start:  1/ 1/84                                                                      Report #:  523-6
                                          EARNED VALUE ANALYSIS BY TIME PERIODS


Selection: All
Early Schedule       From:  1/ 1/84       To:  1/12/84      Weekly                           Data Date :  1/12/84
*******************************************************************************************************************
   TIME PERIOD                BCWS                              BCWP                              ACWP
 -----------------  -------------------------------  ------------------------------  ------------------------------
 FROM      TO         AMOUNT     CUMULATIVE  % TOTAL    AMOUNT   CUMULATIVE % TOTAL     AMOUNT   CUMULATIVE  % TOTAL
*******************************************************************************************************************
 1/ 1/84  1/ 7/84    11122.50     11122.50    42.60    11122.50    11122.50   42.60     6013.40     6013.40   43.87
 1/ 8/84  1/12/84    14982.50     26105.00   100.00    14982.50    26105.00  100.00     7693.50    13706.90  100.00

                    -------------------------------  ------------------------------  ------------------------------

   TOTALS:           26105.00                          26105.00                         13706.90
```

```
Date:  9/ 4/84                 ********************************************                 Page    1
Project Id: HOUSE-2            *              House Construction          *           Last Acc:  9/ 4/84
                               *                 P R O M I S              *           Last Upd:  1/12/84
                               ********************************************
Project start:  1/ 1/84                                                               Report #:  323-6
                                    EARNED VALUE ANALYSIS BY TIME PERIODS

Selection: All
Early Schedule      From:  1/ 1/84      To:  1/12/84      Monthly                     Data Date :  1/12/84
*****************************************************************************************************
  TIME PERIOD                  BCWS                             BCWP                          ACWP
-----------------   ------------------------------   ------------------------------   ------------------------------
 FROM      TO        AMOUNT     CUMULATIVE  % TOTAL    AMOUNT    CUMULATIVE % TOTAL     AMOUNT   CUMULATIVE  % TOTAL
*****************************************************************************************************
 1/ 1/84  1/12/84   26105.00    26105.00   100.00    26105.00    26105.00  100.00    13706.90    13706.90   100.00

                    ------------------------------   ------------------------------   ------------------------------

   TOTALS:          26105.00                          26105.00                          13706.90
```

```
Date:  9/ 4/84                ###########################################                   Page    1
Project Id: HOUSE-2           #            House Construction           #             Last Acc:  9/ 4/84
                              #               P R O M I S               #             Last Upd:  1/12/84
                              ###########################################
Project start:  1/ 1/84                                                               Report #:  541-1
                                        ACTIVITY INPUT LISTING


Selection: All
==================================================================================================
 ACT. SUBPROJ.       ACTIVITY DESCRIPTION        EST   PLANNED  SCHED         ACTIVITY CODES
 ID    ID                                        DUR    START   CONS.  WKC  RESP  AUX1  AUX2  AUX3
==================================================================================================
  1000            BEGIN CONSTRUCTION              1                    5d   FM-B
  1010            EXCAVATE, POUR FOOTER           4                    5d   FM-B
  1020            POUR CONCRETE FOUNDATIONS       2                    5d   FM-A
  1030            ERECT FRAME AND ROOF            4                    5d   FM-A
  1040            LAY BRICKWORK                   6                    5d   FM-A
  1050            INSTALL DRAINS                  1                    5d   FM-A
  1060            POUR BASEMENT FLOOR             2                    5d   FM-B
  1070            INSTALL ROUGH PLUMBING          3                    5d   FM-A
  1080            INSTALL ROUGH WIRING            2                    5d   FM-A
  1090            INSTALL AIR CONDITIONING        4                    5d   FM-B
  1100            FASTEN PLASTER, PLASTER BOARD  10                    5d   FM-B
  1110            LAY FINISHED FLOORING           3                    5d   FM-B
  1120            INSTALL KITCHEN EQUIPMENT       1                    5d   FM-A
  1130            INSTALL FINISHED PLUMBING       2                    5d   FM-A
  1140            FINISH CARPENTRY                3                    5d   FM-B
  1150            FINISH ROOFING AND FLASHING     2                    5d   FM-A
  1160            FASTEN GUTTERS AND DOWNSPOUTS   1                    5d   FM-B
  1170            LAY STORM DRAINS                1                    5d   FM-A
  1180            SAND AND VARNISH FLOORS         2                    5d   FM-A
  1190            PAINT                           3                    5d   FM-C
  1200            FINISH ELECTRICAL WORK          1                    5d   FM-C
  1210            FINISH GRADING                  2                    5d   FM-C
  1220            POUR WALKS, AND LANDSCAPE       5                    5d   FM-C
  9000            FINISH BUILDING THE HOUSE       1                    5d   FM-C
```

```
Date:  9/ 4/84      **************************************        Page    1
Project Id: HOUSE-2  *          House Construction         * Last Acc:  9/ 4/84
                     *             P R O M I S             * Last Upd:  1/12/84
                    **************************************
Project start:  1/ 1/84                                     Report #:  541-2
                                  NETWORK LOGIC

Selection: All
=================================================================================
    PRECEDING                             SUCCEEDING
ACT ID   DESCRIPTION                                                  LAG   LAG
                                   ACT ID   DESCRIPTION               TYPE
=================================================================================
 1000  BEGIN CONSTRUCTION           1010  EXCAVATE, POUR FOOTER        FS     0
 1010  EXCAVATE, POUR FOOTER        1020  POUR CONCRETE FOUNDATIONS    FS     0
 1020  POUR CONCRETE FOUNDATIONS    1030  ERECT FRAME AND ROOF         FS     0
 1020  POUR CONCRETE FUUNDATIONS    1050  INSTALL DRAINS               FS     0
 1020  POUR CONCRETE FOUNDATIONS    1170  LAY STORM DRAINS             FS     0
 1030  ERECT FRAME AND ROOF         1040  LAY BRICKWORK                FS     0
 1030  ERECT FRAME AND ROOF         1080  INSTALL ROUGH WIRING         FS     0
 1030  ERECT FRAME AND ROOF         1090  INSTALL AIR CONDITIONING     FS     0
 1040  LAY BRICKWORK                1150  FINISH ROOFING AND FLASHI    FS     0
 1050  INSTALL DRAINS               1060  POUR BASEMENT FLOOR          FS     0
 1050  INSTALL DRAINS               1070  INSTALL ROUGH PLUMBING       FS     0
 1060  POUR BASEMENT FLOOR          1090  INSTALL AIR CONDITIONING     FS     0
 1070  INSTALL ROUGH PLUMBING       1100  FASTEN PLASTER, PLASTER B    FS     0
 1080  INSTALL ROUGH WIRING         1100  FASTEN PLASTER, PLASTER B    FS     0
 1090  INSTALL AIR CONDITIONING     1100  FASTEN PLASTER, PLASTER B    FS     0
 1100  FASTEN PLASTER, PLASTER B    1110  LAY FINISHED FLOORING        FS     0
 1110  LAY FINISHED FLOORING        1120  INSTALL KITCHEN EQUIPMENT    FS     0
 1110  LAY FINISHED FLOORING        1130  INSTALL FINISHED PLUMBING    FS     0
 1110  LAY FINISHED FLOORING        1140  FINISH CARPENTRY             FS     0
 1120  INSTALL KITCHEN EQUIPMENT    1190  PAINT                        FS     0
 1130  INSTALL FINISHED PLUMBING    1190  PAINT                        FS     0
 1140  FINISH CARPENTRY             1180  SAND AND VARNISH FLOORS      FS     0
 1150  FINISH ROOFING AND FLASHI    1160  FASTEN GUTTERS AND DOWNSP    FS     0
 1160  FASTEN GUTTERS AND DOWNSP    1210  FINISH GRADING               FS     0
 1170  LAY STORM DRAINS             1210  FINISH GRADING               FS     0
 1180  SAND AND VARNISH FLOORS      9000  FINISH BUILDING THE HOUSE    FS     0
 1190  PAINT                        1180  SAND AND VARNISH FLOORS      FS     0
 1190  PAINT                        1200  FINISH ELECTRICAL WORK       FS     0
 1200  FINISH ELECTRICAL WORK       9000  FINISH BUILDING THE HOUSE    FS     0
 1210  FINISH GRADING               1220  POUR WALKS, AND LANDSCAPE    FS     0
 1220  POUR WALKS, AND LANDSCAPE    9000  FINISH BUILDING THE HOUSE    FS     0
```

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Date:  9/ 4/84                  ****************************************             Page    1
Project Id: HOUSE-2             *          House Construction          *         Last Acc:  9/ 4/84
                                *              P R O M I S             *         Last Upd:  1/12/84
                                ****************************************
Project start:  1/ 1/84                                                          Report #:  541-3
                                        RESOURCE REQUIREMENTS LISTING


Selection: ACT(1000-1060)
=============================================================================================================
                                           WORK    RESOURCE                                     DAY  NO. S        OH &
ACTIVITY                         ESTIMATED WEEK ----------------------    QUANTITY   UNITS OF   OF   OF  /  JOB  PROFIT
ID   DESCRIPTION                  DURATION CODE  ID   DESCRIPTION         NEEDED     MEASURE    ACT DAYS O  CODE   (%)
=============================================================================================================
 1000 BEGIN CONSTRUCTION                1   5d   CLAB  COMMON BUILDING LAB   250.00    MHOUR        1    1 S jc1   30.00
 1010 EXCAVATE, POUR FOOTER             4   5d   BRHE  BRICKLAYERS HELPERS   100.00    MHOUR        1    4 S jc3   12.00
                                                 CLAB  COMMON BUILDING LAB   200.00    MHOUR        1    4 O jc1   30.00
 1020 POUR CONCRETE FOUNDATIONS         2   5d   CLAB  COMMON BUILDING LAB   250.00    MHOUR        1    2 S jc1   30.00
 1030 ERECT FRAME AND ROOF              4   5d   CLAB  COMMON BUILDING LAB   360.00    MHOUR        1    4 S jc2   23.00
 1040 LAY BRICKWORK                     6   5d   CLAB  COMMON BUILDING LAB   240.00    MHOUR        1    6 S jc2   25.00
 1050 INSTALL DRAINS                    1   5d   CLAB  COMMON BUILDING LAB    50.00    MHOUR        1    1 S jc2   25.00
 1060 POUR BASEMENT FLOOR               2   5d   CLAB  COMMON BUILDING LAB   250.00    MHOUR        1    2 S jc1   30.00
```

```
Date:  9/ 4/84                    ********************************************                Page    1
Project Id: HOUSE-2               *             House Construction           *           Last Acc:  9/ 4/84
                                  *               P R O M I S                *           Last Upd:  1/12/84
                                  ********************************************
Project start:  1/ 1/84                                                                   Report #:  541-4
                                         FIXED COSTS - LISTING BY ACTIVITY

Selection: ACT[1000-1050]
****************************************************************************************************************
                                                      WORK          COST
ACTIVITY                                  ESTIMATED   WEEK    ------------------------        BUDGET    JOBCODE    OH &
  ID        DESCRIPTION                   DURATION    CODE     ID        DESCRIPTION          AMOUNT               RATE
****************************************************************************************************************
 1010  EXCAVATE, POUR FOOTER                   4        5d      C100      BACKHOE              1000.00     jc3      12.00
                                                                C101      CONCRETE             1500.00     jc3      12.00
 1020  POUR CONCRETE FOUNDATIONS               2        5d      C102      CONCRETE             2700.00     jc3      12.00
                                                                C103      RENTAL FORMS         1900.00     jc3      12.00
 1030  ERECT FRAME AND ROOF                    4        5d      C200      LUMBER               2000.00     jc2      23.00
 1040  LAY BRICKWORK                           6        5d      C300      BRICKS,MORTAR        5000.00     jc2       0.00
 1050  INSTALL DRAINS                          1        5d      C400      DRAINPIPE             400.00     jc2      12.00
                                                                C401      DRAINS                250.00     jc2      12.00
```

```
Date:  9/ 4/84        ****************************************         Page    1
Project Id: HOUSE-2  *            House Construction            * Last Acc:  9/ 4/84
                     *               P R O M I S                * Last Upd:  1/12/84
                     ****************************************
Project start:  1/ 1/84                                          Report #:  541-5
                                PRECEDENCE RELATIONSHIPS


Selection: All
==============================================================================
                PRECEDING        SUCCEEDING     LAGTYPE         LAG
                ACTIVITY         ACTIVITY
==============================================================================
                  1000             1010           FS             0
                  1010             1020           FS             0
                  1020             1030           FS             0
                  1020             1050           FS             0
                  1020             1170           FS             0
                  1030             1040           FS             0
                  1030             1080           FS             0
                  1030             1090           FS             0
                  1040             1150           FS             0
                  1050             1060           FS             0
                  1050             1070           FS             0
                  1060             1090           FS             0
                  1070             1100           FS             0
                  1080             1100           FS             0
                  1090             1100           FS             0
                  1100             1110           FS             0
                  1110             1120           FS             0
                  1110             1130           FS             0
                  1110             1140           FS             0
                  1120             1190           FS             0
                  1130             1190           FS             0
                  1140             1180           FS             0
                  1150             1160           FS             0
                  1160             1210           FS             0
                  1170             1210           FS             0
                  1180             9000           FS             0
                  1190             1180           FS             0
                  1190             1200           FS             0
                  1200             9000           FS             0
                  1210             1220           FS             0
                  1220             9000           FS             0
```

```
Date:  9/ 4/84         ****************************************              Page    1
Project Id: HOUSE-2  *          House Construction            * Last Acc:  9/ 4/84
                     *             P R O M I S                * Last Upd:  1/12/84
                       ****************************************
Project start:  1/ 1/84                                          Report #:  541-6
                                   MILESTONE LISTING

Selection: All
==========================================================================================
MILESTONE
--------------------                                           ACTIVITY
                                            TARGET START/      ------------
ID    DESCRIPTION                            DATE  FINISH      DESCRIPTION
==========================================================================================
 1000 START OF PROJECT                       1/ 1/84 S BEGIN CONSTRUCTION
 1010 start excavation                       1/ 3/84 S EXCAVATE, POUR FOOTER
```

```
Date:  9/ 4/84        ****************************************          Page    1
Project Id: HOUSE-2   *          House Construction           * Last Acc:  9/ 4/84
                      *             P R O M I S               * Last Upd:  1/12/84
                      ****************************************
Project start:  1/ 1/84                                         Report #:  542-1
                             ACTUAL SCHEDULE LISTING

Selection: ACT[1000-1070]
================================================================================
                                              EARLY/   ACTUAL
 ACT.  DESCRIPTION                       EST  LATE     START/   SCHED    %COMPL/
 ID                                      DUR  START    FINISH   FINISH   REM DUR
================================================================================
 1000 BEGIN CONSTRUCTION                  1   1/ 2/84  1/ 2/84  1/ 2/84 100.00
                                              1/ 2/84  1/ 2/84                0
 1010 EXCAVATE, POUR FOOTER               4   1/ 3/94  1/ 3/84  1/ 6/84 100.00
                                              1/ 3/84  1/ 6/84                0
 1020 POUR CONCRETE FOUNDATIONS           2   1/ 9/84  1/ 9/84  1/10/84 100.00
                                              1/ 9/84  1/10/84                0
 1030 ERECT FRAME AND ROOF                4   1/11/84  1/11/84  1/16/84  50.00
                                              1/11/84                         2
 1040 LAY BRICKWORK                       6   1/17/84           1/24/84   0.00
                                              1/27/84                         6
 1050 INSTALL DRAINS                      1   1/11/84  1/11/84  1/11/84 100.00
                                              1/12/84  1/11/84                0
 1060 POUR BASEMENT FLOOR                 2   1/12/84  1/12/84  1/13/84  50.00
                                              1/13/84                         1
 1070 INSTALL ROUGH PLUMBING              3   1/12/84  1/12/84  1/16/84  33.33
                                              1/18/84                         2
```

```
Date:  9/ 4/84                        ****************************************
Project Id: HOUSE-2                   *          House Construction          *            Page   1
                                      *             P R O M I S              *      Last Acc:  9/ 4/84
                                      ****************************************      Last Upd:  1/12/84
Project start:  1/ 1/84
                                                                                    Report #:  542-2
                                           RESOURCE USAGE LISTING

Selection: ACT(1000-1070)
------------------------------------------------------------------------------------------------------------
ACT                               ACTUAL                                                           DAY RES  NUM DAYS
ID   DESCRIPTION                  START/  RESOURCE                     JOB   OH %    UNITS   UNITS  STARTED/ USED/
                                  FINISH  ID    DESCRIPTION            CODE  PROFIT  USED    LEFT   NEEDED   REMAIN
------------------------------------------------------------------------------------------------------------
1000 BEGIN CONSTRUCTION           1/ 2/84 CLAB  COMMON BUILDING LAB    jc1   30.00   16.00   0.00   1/ 2/84    1
                                  1/ 2/84
1010 EXCAVATE, POUR FOOTER        1/ 3/84 BRHE  BRICKLAYERS HELPERS    jc3   12.00   100.00  0.00   1/ 3/84    0
                                  1/ 6/84                                                                     1
                                          CLAB  COMMON BUILDING LAB    jc1   30.00   280.00  0.00   1/ 3/84    0
                                                                                                              1
1020 POUR CONCRETE FOUNDATIONS    1/ 9/84 CLAB  COMMON BUILDING LAB    jc1   30.00   250.00  0.00   1/ 9/84    0
                                  1/10/84                                                                     1
1030 ERECT FRAME AND ROOF         1/11/84 CLAB  COMMON BUILDING LAB    jc2   23.00   180.00  180.00 1/11/84    0
                                                                                                              2
1040 LAY BRICKWORK                        CLAB  COMMON BUILDING LAB    jc2   25.00   0.00    240.00 1/12/84    2
                                                                                                              0
1050 INSTALL DRAINS               1/11/84 CLAB  COMMON BUILDING LAB    jc2   25.00   50.00   0.00   1/11/84    6
                                  1/11/84                                                                     1
1060 POUR BASEMENT FLOOR          1/12/84 CLAB  COMMON BUILDING LAB    jc1   30.00   120.00  130.00 1/12/84    0
                                                                                                              1
1070 INSTALL ROUGH PLUMBING       1/12/84 CLAB  COMMON BUILDING LAB    jc2   23.00   90.00   180.00 1/12/84    1
                                                                                            1/12/84    1
                                                                                            1/12/84    2
```

```
Date:  9/ 4/84                       ******************************************
Project Id: HOUSE-2                  *          House Construction            *      Page    1
                                     *              P R O M I S               *  Last Acc:  9/ 4/84
Project start:  1/ 1/84              ******************************************  Last Upd:  1/12/84

                                           ACTUAL COST LISTING                   Report #:  542-3

Selection: ACT[1000-1050]
=================================================================================================
ACTIVITY                       ACTUAL                                        COST
ID   DESCRIPTION               START/  COST                    JOB   OH &    USED/      TOTAL
                               FINISH  ID    DESCRIPTION       CODE  PROFIT  REMAIN     COST
=================================================================================================
1000 BEGIN CONSTRUCTION        1/ 2/84
                               1/ 2/84                                 0.00     0.00     0.00
1010 EXCAVATE, POUR FOOTER     1/ 3/84 C100  BACKHOE                            0.00
                               1/ 6/84                         jc3    12.00     0.00  1000.00
                                       C101  CONCRETE                        1000.00
                                                               jc3    12.00     0.00  1500.00
1020 POUR CONCRETE FOUNDATIONS 1/ 9/84 C102  CONCRETE                        1500.00
                               1/10/84                         jc3    12.00     0.00  2700.00
                                       C103  RENTAL FORMS                    2700.00
                                                               jc3    12.00     0.00  1900.00
1030 ERECT FRAME AND ROOF      1/11/84 C200  LUMBER                          1900.00
                                                               jc2    23.00     0.00  2000.00
1050 INSTALL DRAINS            1/11/84 C400  DRAINPIPE                       2000.00
                               1/11/84                         jc2    12.00     0.00   400.00
                                       C401  DRAINS                           400.00
                                                               jc2    12.00     0.00   250.00
                                                                              250.00
```

```
Date:  9/ 4/84       **************************************          Page    1
Project Id: HOUSE-2  *         House Construction           * Last Acc:  1/ 1/85
                     *             P R O M I S              * Last Upd:  1/ 1/85
                     **************************************
Project start:  1/ 1/84                                       Report #:  543-1
                                PROJECT HOLIDAY TABLE

Selection: All
===============================================================================

                    HOLIDAY                          DESCRIPTION

===============================================================================

                    2/22/84          WASHINGTON'S BIRTHDAY
                    7/ 4/84          INDEPENDENCE DAY
                   10/12/84          COLUMBUS DAY
```

```
Date:  9/ 4/84        ****************************************             Page    1
Project Id: HOUSE-2  *           House Construction           * Last Acc:  1/ 1/85
                     *               P R O M I S              * Last Upd:  1/ 1/85
                     ****************************************
Project start:  1/ 1/84                                       Report #:  543-2
                               PROJECT RESOURCE TABLE


Selection: All
===============================================================================
RESOURCE     DESCRIPTION          UNITS OF   STANDARD OVERTIME  DEF. OH. MAX DAILY
 ID                               MEASURE    RATE     RATE      PROFIT   AVAILABLE
===============================================================================
BRHE     BRICKLAYERS HELPERS     MHOUR         11.45   16.90     30.00        0.00
BRIC     BRICKLAYERS             MHOUR         14.50   21.75     30.00        0.00
CARP     CARPENTERS              MHOUR         14.10   21.40     30.00        0.00
CEFI     CEMENT FINISHER         MHOUR         13.80   20.90     30.00        0.00
CLAB     COMMON BUILDING LAB     MHOUR         11.15   16.75     30.00        0.00
ELEC     ELECTRICIANS            MHOUR         16.05   25.07     30.00        0.00
GLAZ     GLAZIERS                MHOUR         13.80   20.90     30.00        0.00
PLAH     PLASTERER HELPER        MHOUR         11.60   17.40     30.00        0.00
PLAS     PLASTERER               MHOUR         13.60   20.30     30.00        0.00
PLUM     PLUMBER                 MHOUR         14.10   21.15     23.00        0.00
PORD     PAINTERS, ORDINARY      MHOUR         13.20   20.00     30.00        0.00
ROFC     ROOFERS, COMPOSIT.      MHOUR         13.40   20.10     30.00        0.00
ROHE     ROOFER HELPER(COMP)     MHOUR         10.05   15.50     30.00        0.00
ROTS     ROOFER, TILE & SLATE    MHOUR         13.55   20.25     30.00        0.00
```

```
Date:  9/ 4/84       ****************************************          Page    1
Project Id: HOUSE-2  *           House Construction           * Last Acc:  1/ 1/85
                     *              P R O M I S               * Last Upd:  1/ 1/85
                     ****************************************
Project start:  1/ 1/84                                        Report #:  61-4
                              WORK WEEK CODE LISTING

Selection: All
==================================================================================
                     WORK                               # OF
                     WEEK           STARTING          WORKING
                     CODE              DAY              DAYS
==================================================================================
                     5D/W               1                 5
                     5d                 1                 5
                     6d                 1                 6
```

```
Date:  9/ 4/84         **************************************          Page    1
Project Id: HOUSE-2  *          House Construction           * Last Acc:  1/ 1/85
                     *               P R O M I S             * Last Upd:  1/ 1/85
                     **************************************
Project start:   1/ 1/84                                      Report #:  61-5
                              STANDAFD HOLIDAY TADLE

Selection: All
================================================================================

                    HOLIDAY                             DESCRIPTION

================================================================================

                     1/ 1/85                     New Year
                     7/ 4/84                     Independence Day
                    12/25/84                     Christmas
```

```
Date:  9/ 4/84        ****************************************             Page    1
Project Id: HOUSE-2  *          House Construction          * Last Acc:  9/ 4/84
                     *             P R O M I S              * Last Upd:  1/13/84
                     ****************************************
Project start:  1/ 1/84                                     Report #:  61-6
                               STANDARD RESOURCE TABLE

Selection: All
================================================================================
   RESOURCE                              UNITS OF   STANDARD OVERTIME  DEF. OH.
     ID          DESCRIPTION             MEASURE      RATE     RATE    PROFIT
================================================================================
    BRHE     BRICKLAYERS HELPERS        MHOUR        11.45    16.90     30.00
    BRIC     BRICKLAYERS                MHOUR        14.50    21.75     30.00
    CARP     CARPENTERS                 MHOUR        14.10    21.40     30.00
    CEFI     CEMENT FINISHER            MHOUR        13.80    20.90     30.00
    CLAB     COMMON BUILDING LAB        MHOUR        11.15    16.75     30.00
    ELEC     ELECTRICIANS               MHOUR        16.05    25.07     30.00
    GLAZ     GLAZIERS                   MHOUR        13.80    20.90     30.00
    PLAH     PLASTERER HELPER           MHOUR        11.60    17.40     30.00
    PLAS     PLASTERER                  MHOUR        13.60    20.30     30.00
    PLUM     PLUMBER                    MHOUR        14.10    21.15     23.00
    PORD     PAINTERS, ORDINARY         MHOUR        13.20    20.00     30.00
    ROFC     ROOFERS, COMPOSIT.         MHOUR        13.40    20.10     30.00
    ROHE     ROOFER HELPER(COMP)        MHOUR        10.05    15.50     30.00
    ROTS     ROOFER, TILE & SLATE       MHOUR        13.55    20.25     30.00
```

```
Date:  9/ 4/84                      **********************************************                   Page    1
Project Id: HOUSE-2                 *              House Construction            *             Last Acc:  9/ 4/84
                                    *                P R O M I S                 *             Last Upd:  1/12/84
                                    **********************************************
Project start:  1/ 1/84                                                                        Report #:  634
                                                  PROJECT INPUT LISTING

Selection: ID(HOUSE-TUTOR2)
==========================================================================================================================
                 PROJECT
-------------------------------------------   CONTRACT   START                         NO.    NO.     LAST     LAST    DEFAULT
   ID           DESCRIPTION                    AMOUNT    DATE   DEADLINE  DURATION  ACTS.   RES.   ACCESS   UPDATE     WWF
==========================================================================================================================
  HOUSE  House Construction                  100000.00  1/ 1/84  3/27/84       36      24     13   1/ 1/84               5d
        OWNER:                  MANAGER:                      LOCATION:Cambridge, MA   USA COMMENT:

HOUSE-2  House Construction                  100000.00  1/ 1/84  3/27/84       28      24     13   9/ 4/84  1/12/84      5d
        OWNER:                  MANAGER:                      LOCATION:Cambridge, MA   USA COMMENT:

  TUTOR  Project Management System            10000.00  1/ 2/84                13       5      3   9/ 4/84               5d
        OWNER:Anyfirm, USA, Inc.   MANAGER:Joe H. Brown       LOCATION:Central City        COMMENT:

 TUTOR2  Project Management System            10000.00  1/ 2/84  1/30/84        8       5      3  10/18/84  1/16/84      5d
        OWNER:Anyfirm, USA, Inc.   MANAGER:Joe H. Brown       LOCATION:Central City        COMMENT:
```

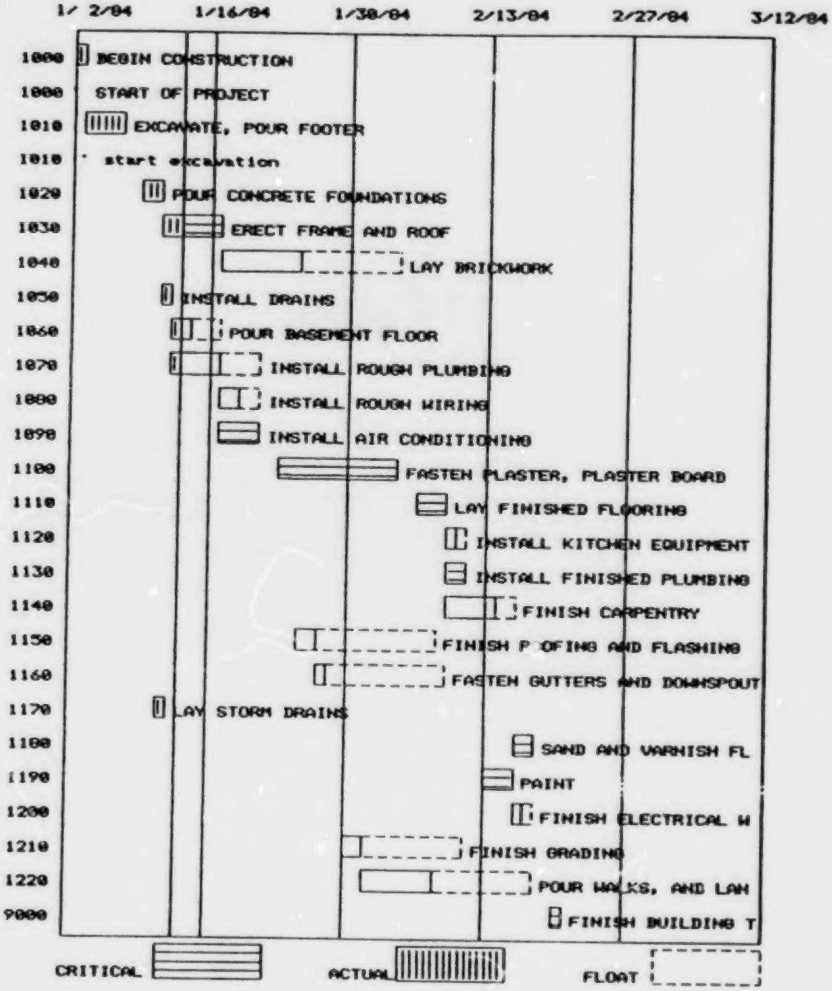
House Construction

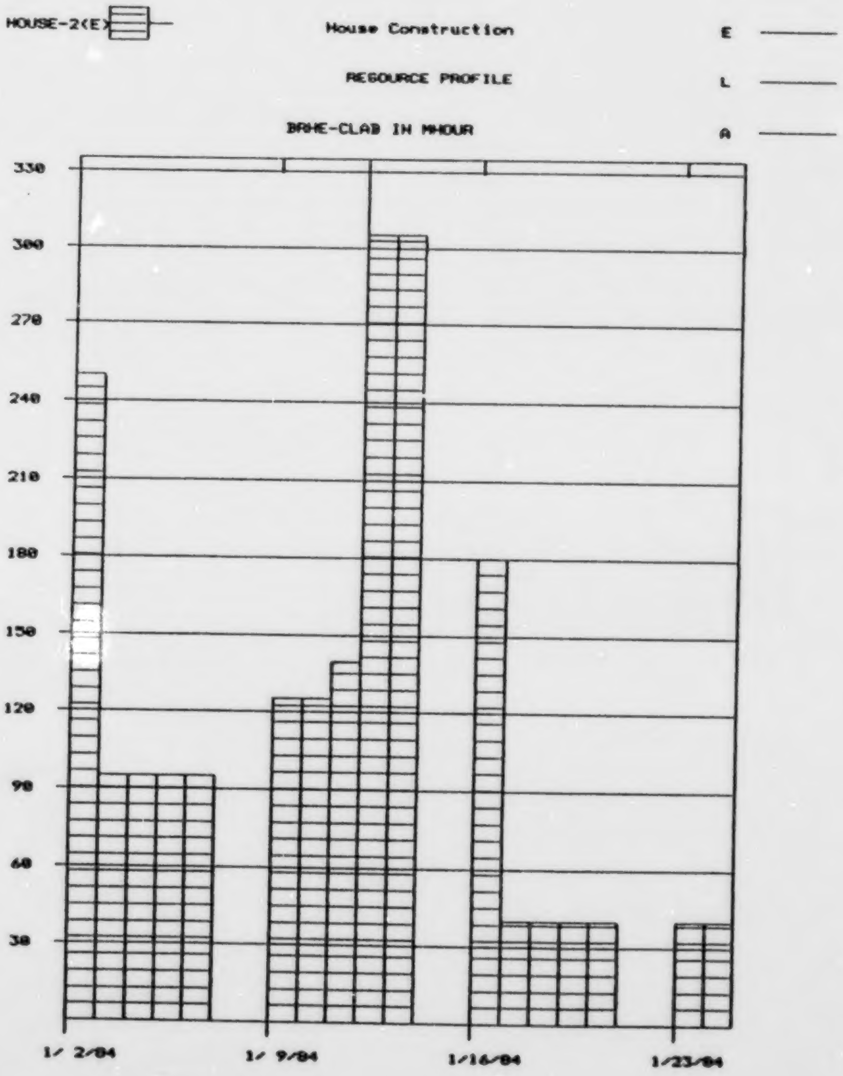
Project : HOUSE-2 acc : 9/ 4/84

PROMIS

demo project upd : 1/12/84

GANTT CHART

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L
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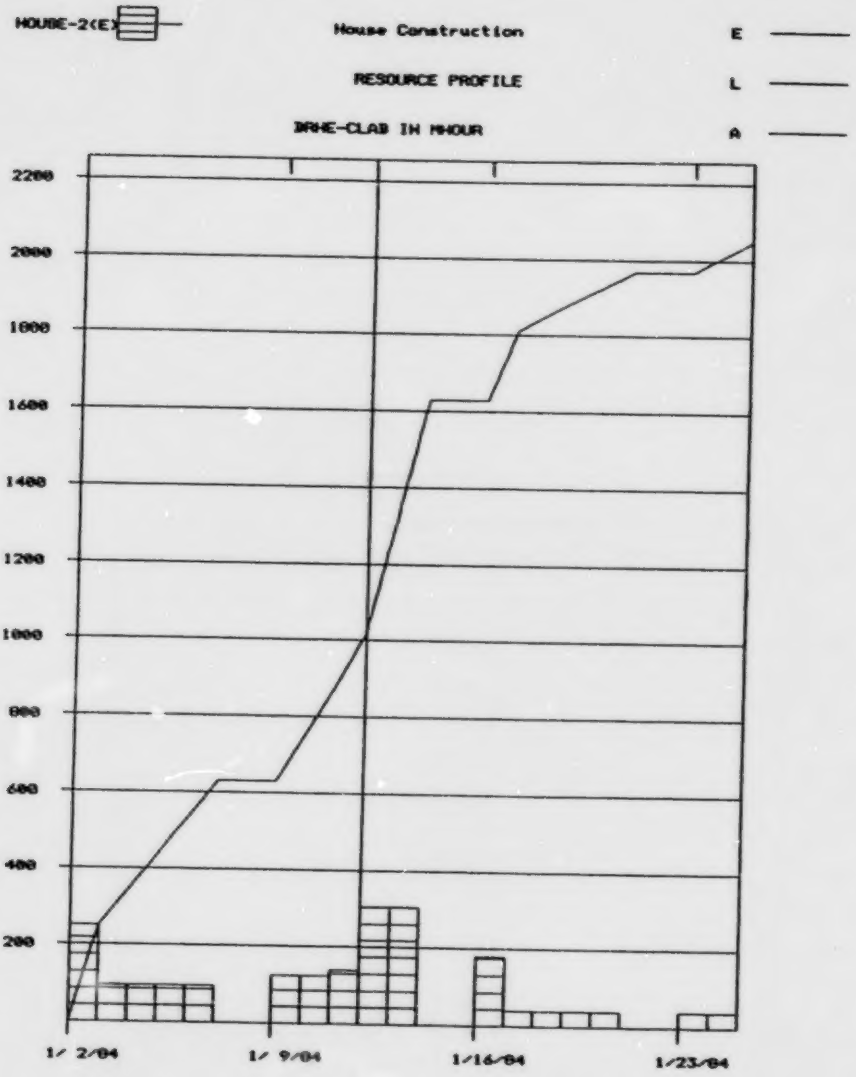
1/ 9/84
1/16/84
1/23/84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E
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800
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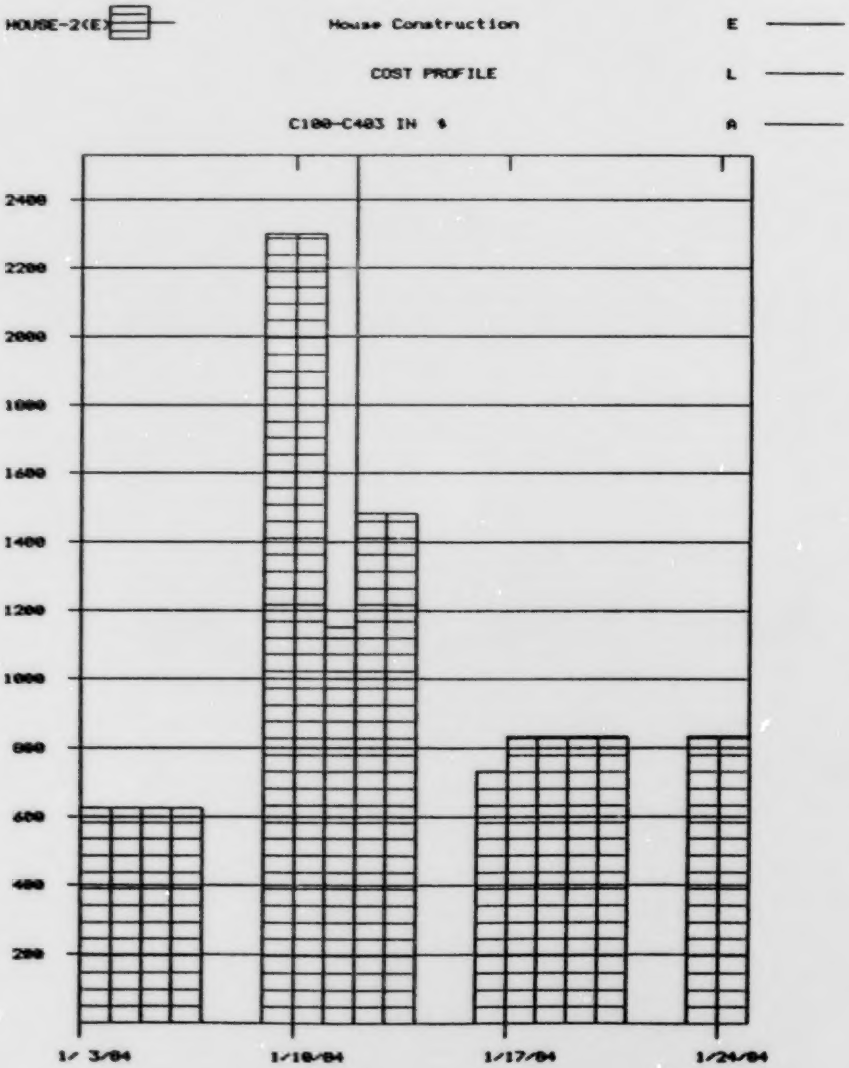
1/ 9/84
1/16/84
1/23/84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L
A
2400
2200
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1800
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1400
1200
1000
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600
400
200
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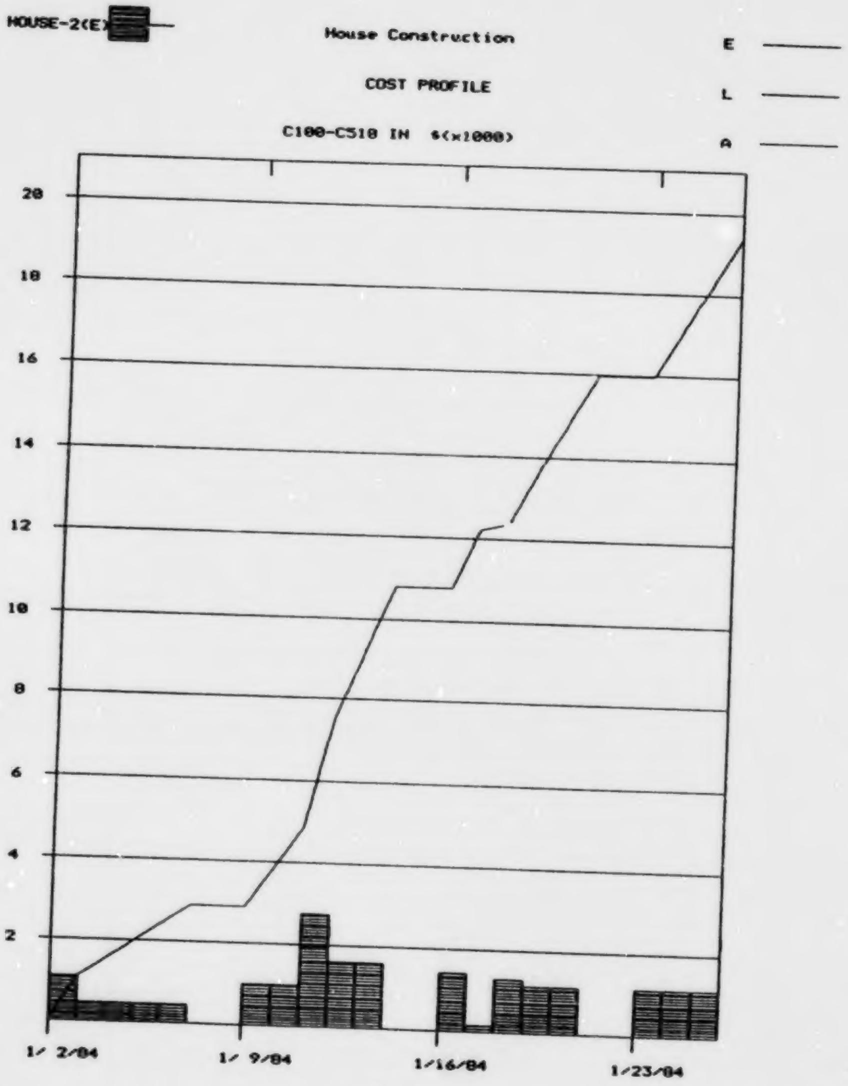
1/10/84
1/17/84
1/24/84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E
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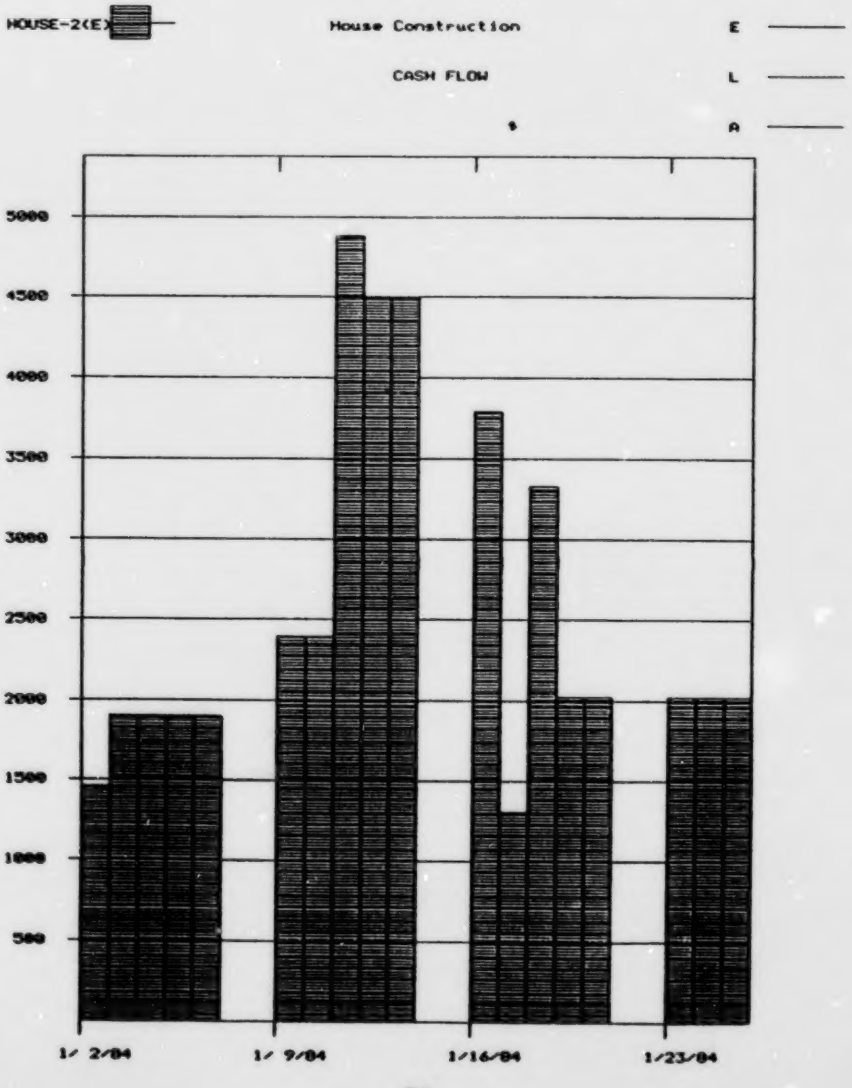
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1/ 9/84
1/16/84
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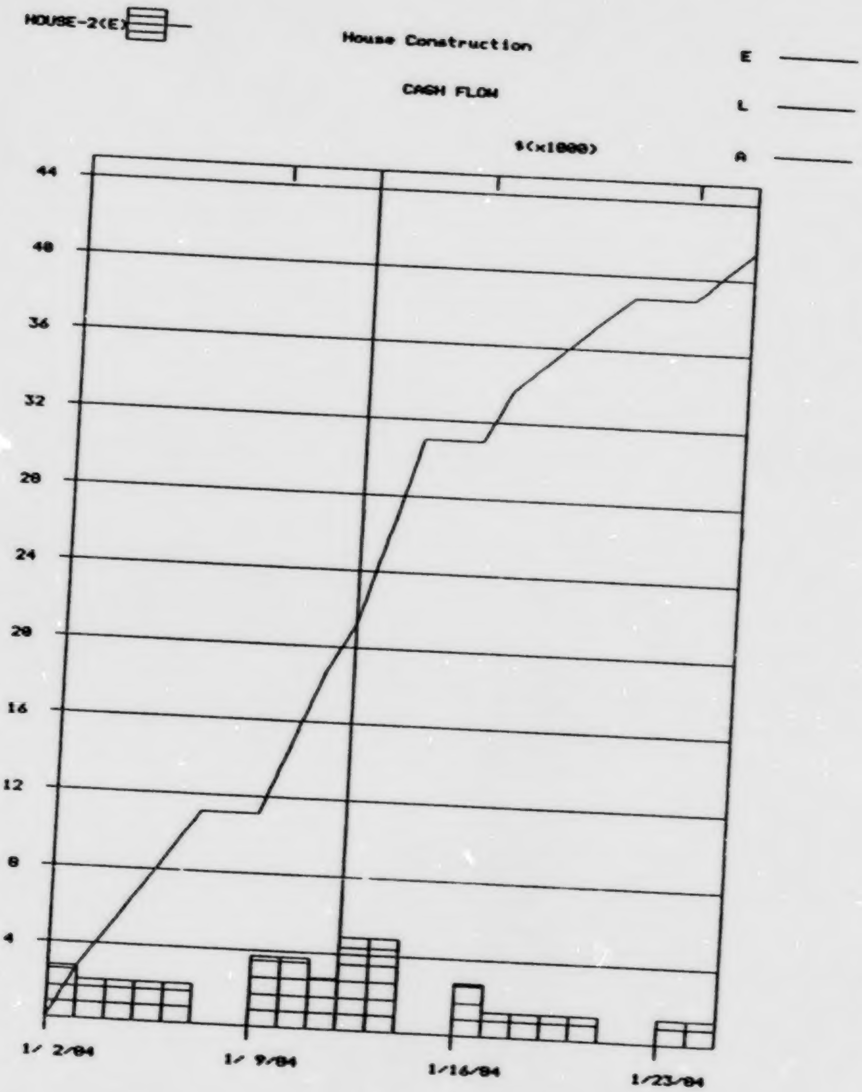
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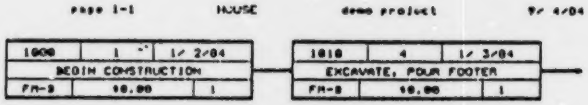
1/ 9/84
1/16/84
1/23/84


page 1-1
HOUSE
demo project
9/ 4/84
1000
1
1/ 2/84
BEGIN CONSTRUCTION
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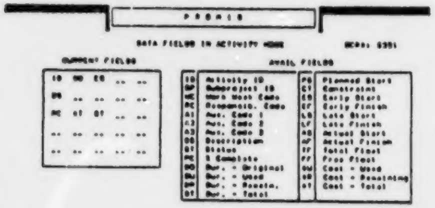
1
1010
4
1/ 3/84
EXCAVATE, POUR FOOTER
FM-B
$0.00
1



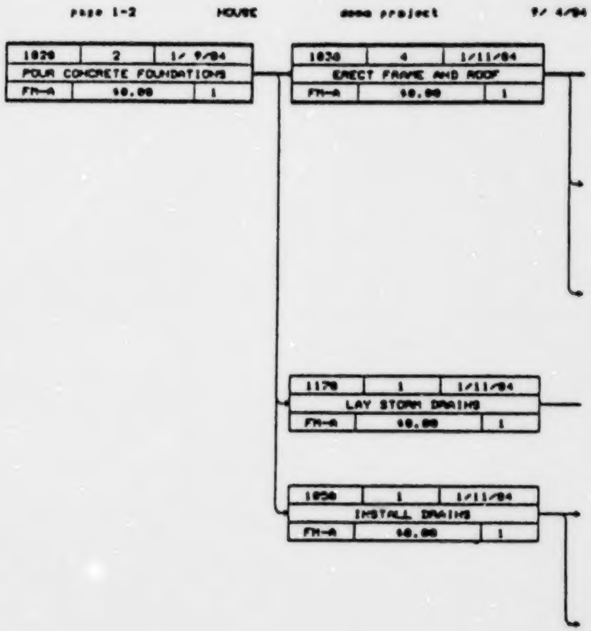
DATA FIELDS IN ACTIVITY NODE MEM: 6391

CURRENT FIELDS

ID	DO	ES	--	--
DS	--	--	--	--
RC	CT	DT	--	--
--	--	--	--	--
--	--	--	--	--

AVAIL FIELDS

ID	Activity ID	PS	Planned Start
SP	Subproject ID	CT	Constraint
WC	Work Unit Code	ES	Early Start
RC	Responsib. Code	EF	Early Finish
A1	Acc. Code 1	LS	Late Start
A2	Acc. Code 2	LF	Late Finish
A3	Acc. Code 3	AS	Actual Start
DS	Description	AF	Actual Finish
ST	Status	TF	Total Float
PC	% Complete	FF	Free Float
DO	Dur. - Original	CU	Cost - Used
DU	Dur. - Used	CR	Cost - Remaining
DR	Dur. - Remain.	CT	Cost - Total
DT	Dur. - Total		


page 1-2
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9/ 4/84
1020
2
1/ 9/84
POUR CONCRETE FOUNDATIONS
FM-A
$0.00
1
1030
4
1/11/84
ERECT FRAME AND ROOF
FM-A
$0.00
1
1170
1
1/11/84
LAY STORM DRAINS
FM-A
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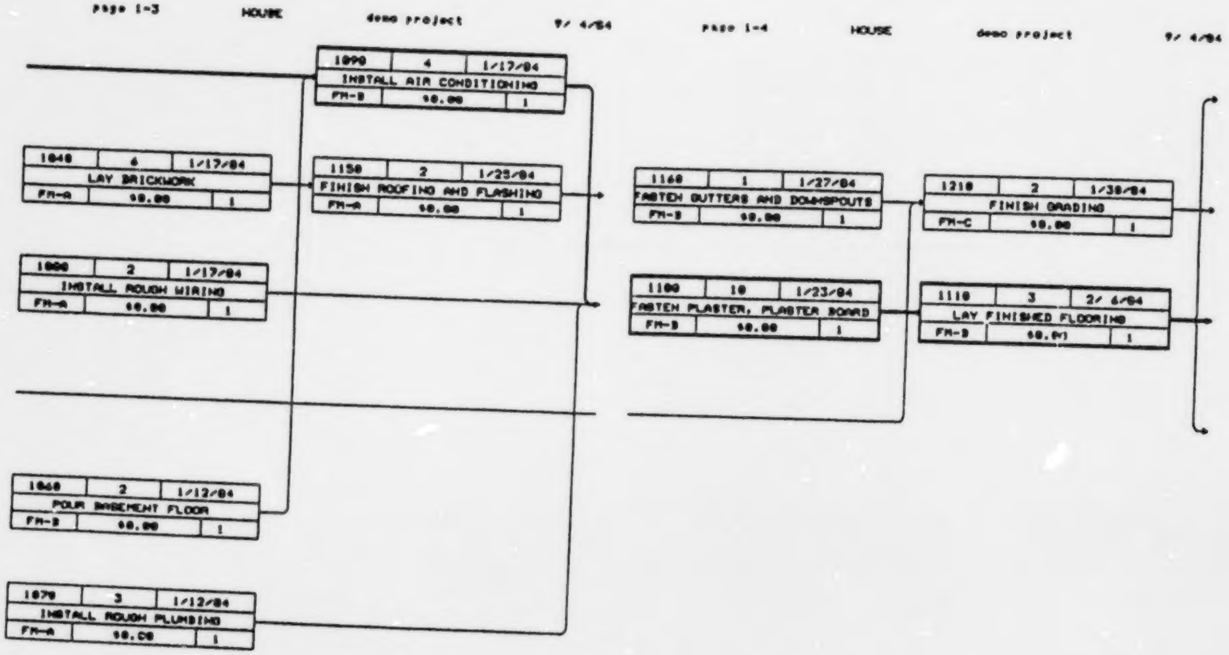
1
1050
1
1/11/84
INSTALL DRAINS
FM-A
$0.00
1


Page 1-3
HOUSE
demo project
9/ 4/84
Page 1-4
HOUSE
demo project
9/ 4/84
1090 4 1/17/84
INSTALL AIR CONDITIONING
FM-B $0.00 1
1040 6 1/17/84
LAY BRICKWORK
FM-A $0.00 1
1150 2 1/25/84
FINISH ROOFING AND FLASHING
FM-A $0.00 1
1080 2 1/17/84
INSTALL ROUGH WIRING
FM-A $0.00 1
1060 2 1/12/84
POUR BASEMENT FLOOR
FM-B $0.00 1
1070 3 1/12/84
INSTALL ROUGH PLUMBING
FM-A $0.00 1
1160 1 1/27/84
FASTEN GUTTERS AND DOWNSPOUTS
FM-B $0.00 1
1100 10 1/23/84
FASTEN PLASTER, PLASTER BOARD
FM-B $0.00 1
1210 2 1/30/84
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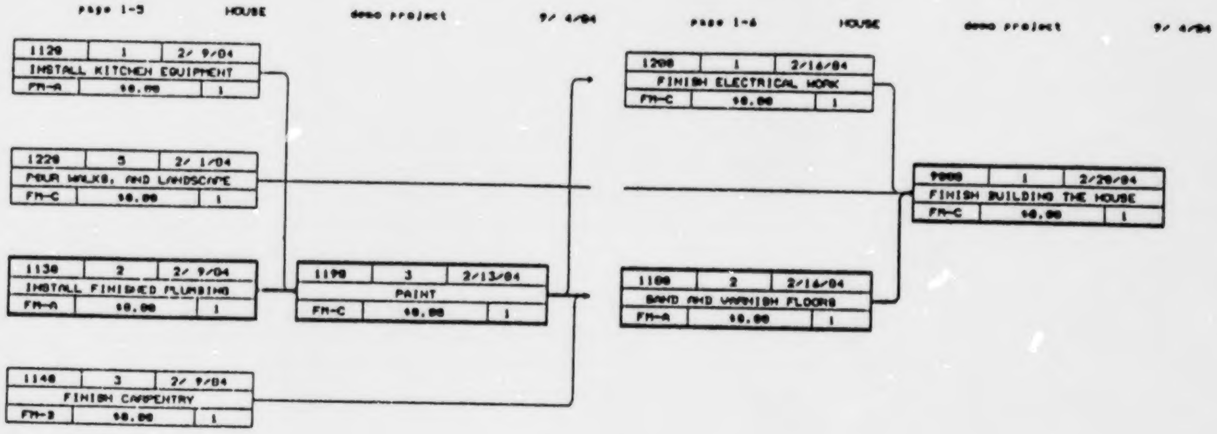
FM-C $0.00 1
1110 3 2/ 6/84
LAY FINISHED FLOORING
FM-B $0.00 1


page 1-5
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2/ 9/84
INSTALL KITCHEN EQUIPMENT
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1220
5
2/ 1/84
POUR WALKS, AND LANDSCAPE
FM-C
$0.00
1
1130
2
2/ 9/84
INSTALL FINISHED PLUMBING
FM-A
$0.00
1
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3
2/ 9/84
FINISH CARPENTRY
FM-B
$0.00
1
1190
3
2/13/84
PAINT
FM-C
$0.00
1
page 1-6
HOUSE
demo project
9/ 4/84
1200
1
2/16/84
FINISH ELECTRICAL WORK
FM-C
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1
1100
2
2/16/84
SAND AND VARNISH FLOORS
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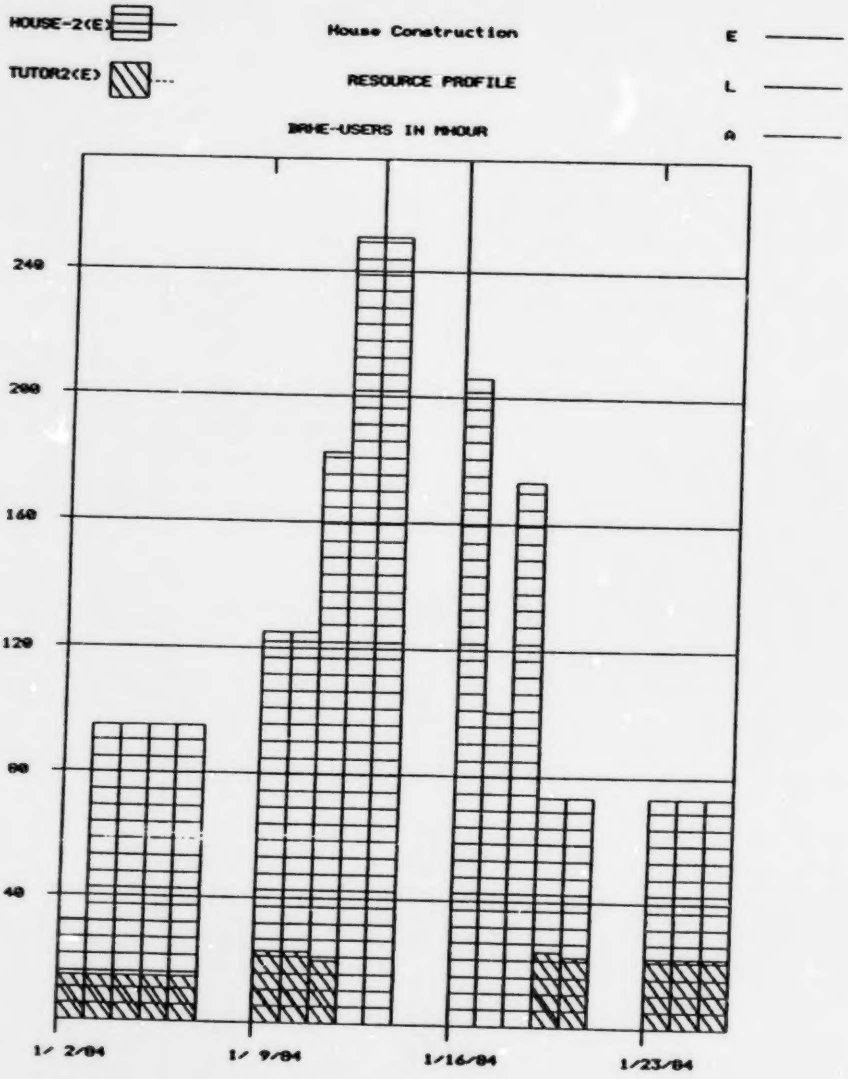
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House Construction
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L
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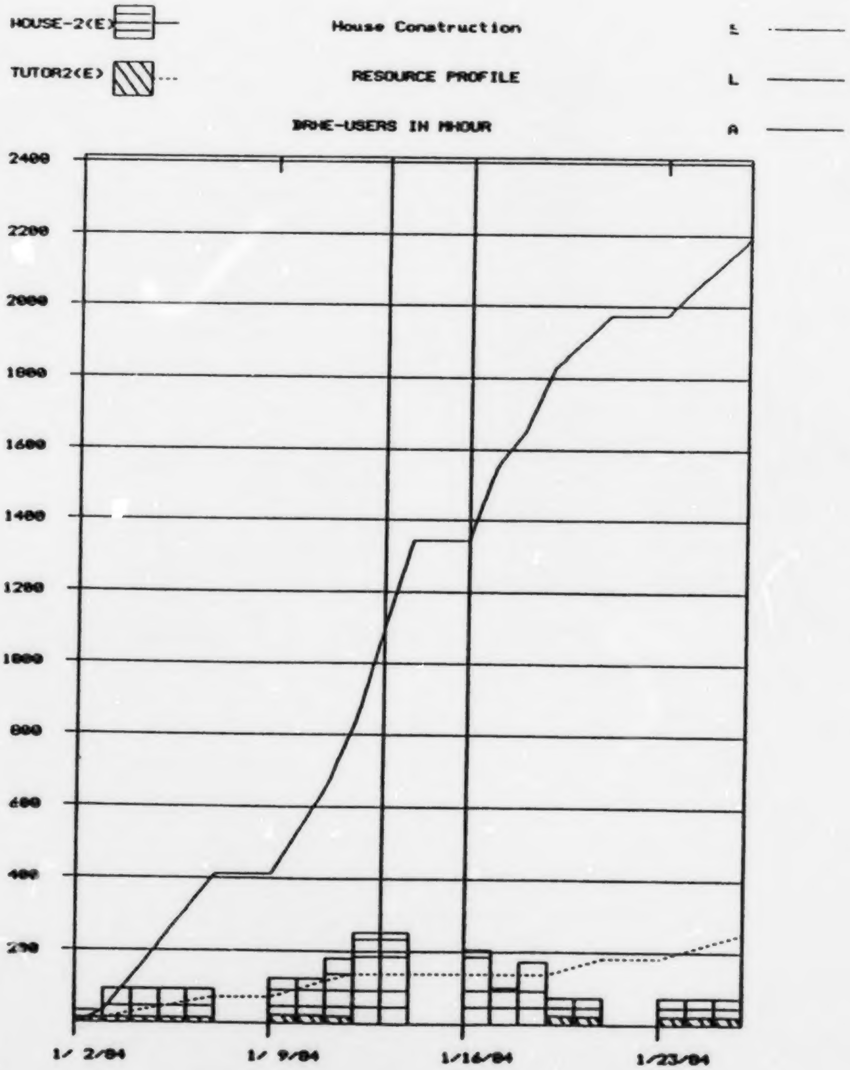
1/ 9/84
1/16/84
1/23/84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TUTOR2(E)
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RESOURCE PROFILE
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2400
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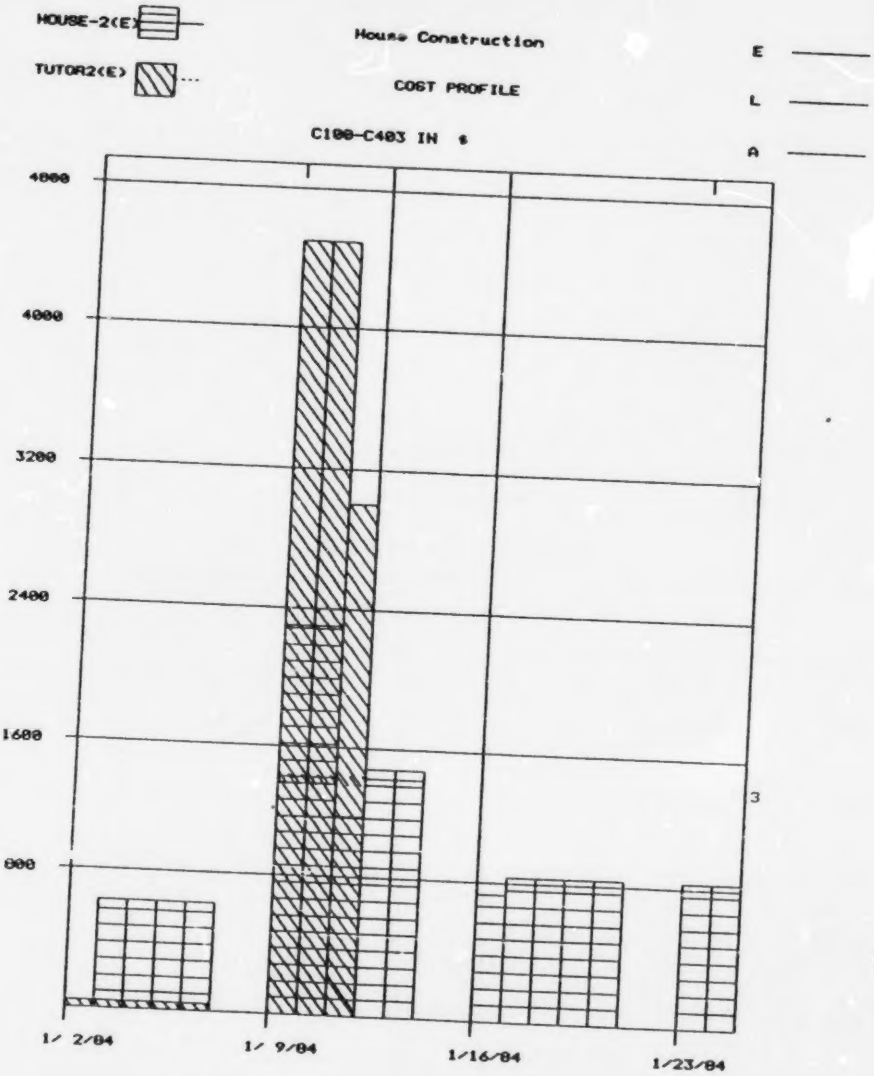
1/ 9/84
1/16/84
1/23/84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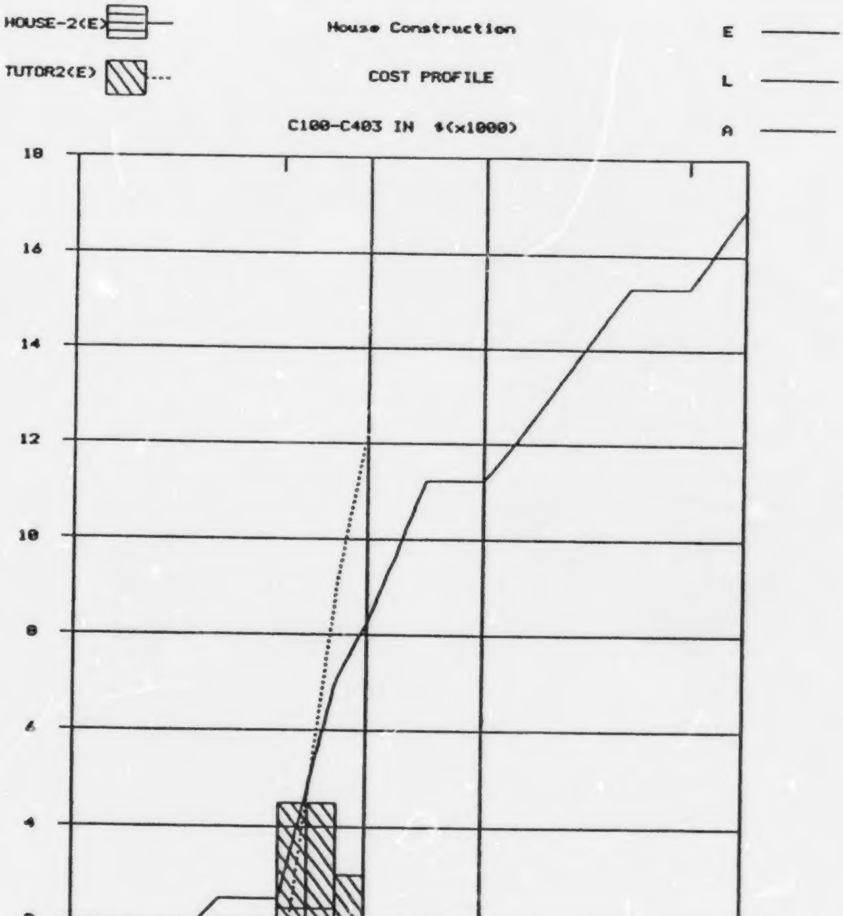
1/16/84
1/23/84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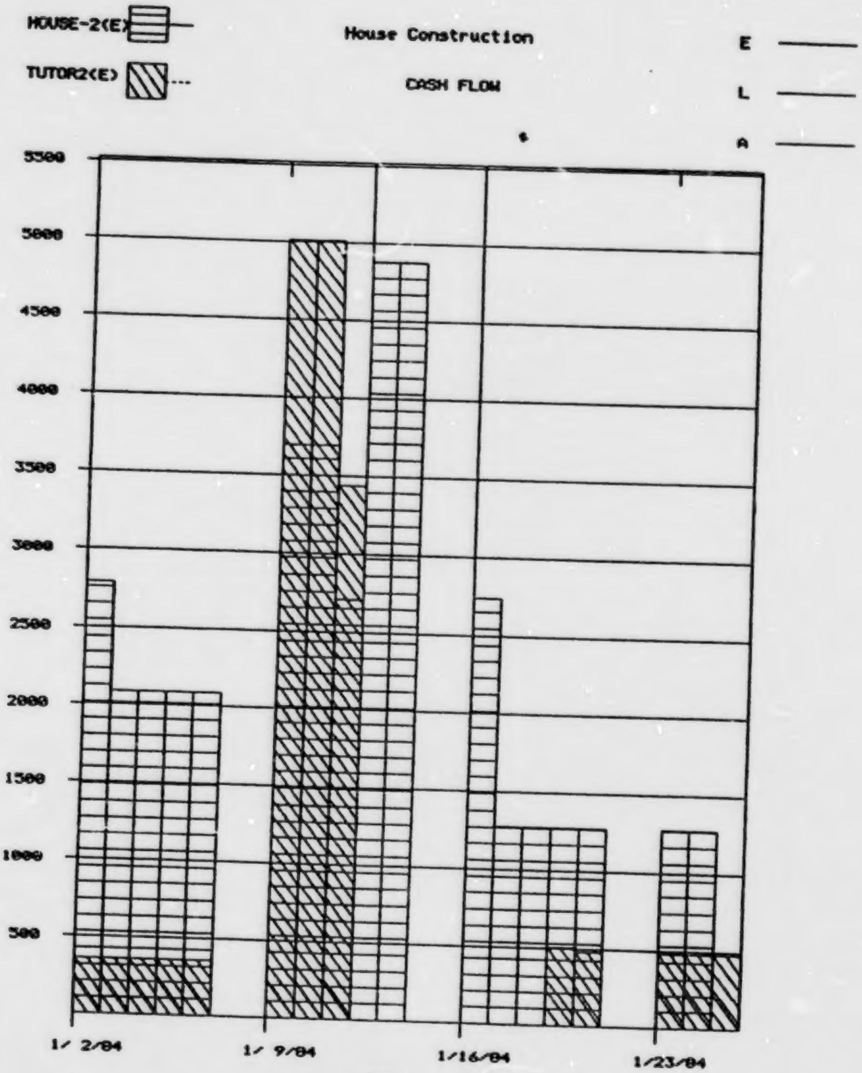
1/16/84
1/23/84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TUTOR2(E)
House Construction
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1/ 9/84
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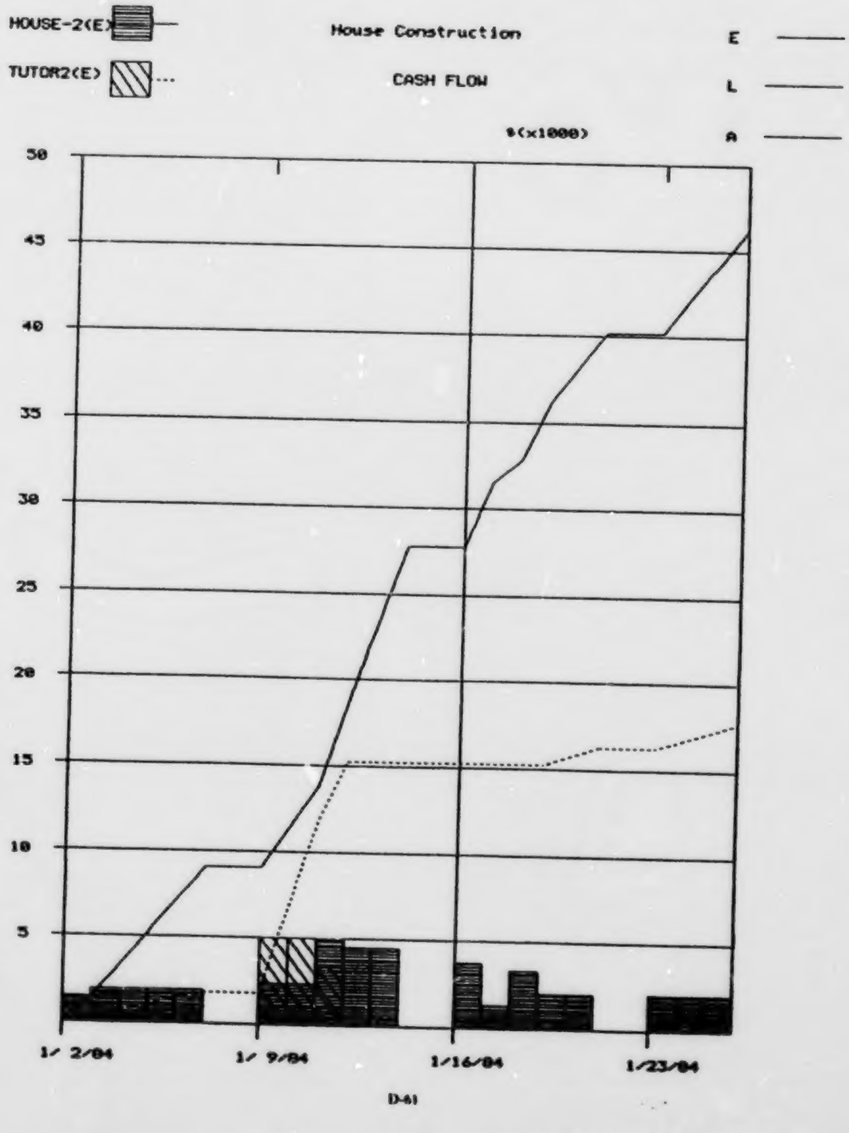
1/23/84


HOUSE-2(E) ▤
TUTOR2(E) ▧
House Construction
CASH FLOW
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L
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40
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25
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15
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5
1/ 2/84
1/ 9/84
1/16/84
1/23/84

Volume

3

TP6089E

CANADIAN AIRSPACE SYSTEM

VOLUME III IDENTIFICATION AND CONSOLIDATION OF HIERARCHY OF DOCUMENTATION

APRIL 1985

CA1
DTC 247
85
C113
c.2

CANADIAN AIRSPACE SYSTEM

VOLUME 3: IDENTIFICATION AND CONSOLIDATION OF HIERARCHY OF DOCUMENTATION

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Associates, Inc.
(Washington, D.C.)

James F. Hickling
Management Consultants Ltd.
(Ottawa)

PREPARED FOR THE CANADIAN AIR TRANSPORTATION ADMINISTRATION
AND THE
TRANSPORTATION DEVELOPEMENT CENTRE

SEPTEMBER 1985

The contents of this report reflect the views of the contractor and not necessarily the official views or policies of Transport Canada.

PROJECT TEAM

The project team for Jerry Thompson & Associates Inc. was composed of:

Mr. G. L. Thompson
Mr. D. Kan

REPORT DOCUMENTATION FORM

1. Transport Canada Report No.
TP6069E

2. TDC Project No.
6280/6281

3. Recipient's Catalogue No.

4. Title and Subtitle
CANADIAN AIRSPACE SYSTEMS ENGINEERING PLAN
VOLUME 3: IDENTIFICATION AND CONSOLIDATION OF
HIERARCHY OF DOCUMENTATION

5. Report Date
April 1985

6. Performing Organization Report No.
1401

7. Author(s) G. THOMPSON, D. KAN

8. Transport Canada File No.
D1455-164

9. Performing Organization Name and Address

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OTTAWA, ONTARIO
K1R 7S8

JERRY THOMPSON AND ASSOCIATES INC.
3212 McCOMAS AVENUE
SILVER SPRING, MD.
USA

10. DSS File No.
03MS. T8200-4-4523

11. DSS or Transport Canada Contract No.
OMS84-01253

12. Sponsoring Agency Name and Address

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GUY FAVREAU COMPLEX
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MONTREAL, QUEBEC
H2Z 1X4

FACILITY ENGINEERING &
SYSTEMS DEVELOPMENT,
AIR NAVIGATION,
CANADIAN AIR TRANSPORTATION
ADMINISTRATION, TOWER A,
PLACE DE VILLE, OTTAWA K1A 0N5

13. Type of Report and Period Covered
FINAL JAN.'85-SEPT.'85

14. Sponsoring Agency Code
6280/81

15. Supplementary Notes

16. TDC Project Officer
MICHA AVNI

17. Abstract

The Canadian Airspace System Plan (CASP) is a comprehensive plan for modernizing and improving the Canadian Airspace System. There are literally thousands of air traffic control and air navigation facilities comprising the Canadian Airspace System. Projects to modernize these facilities are in various stages of implementation. Implementation of some projects may dictate changes in, or alterations to, air traffic procedures, aircraft equipage, or flight procedures as well as impacting other projects. The Canadian Airspace Systems Engineering Plan describes a unique systems engineering based approach for organizing and managing the implementation of CASP.
Volume 1: Systems Engineering Management Implementation Plan: This report describes a series of systems engineering planning activities and processes; structures the many individual projects in the Canadian Airspace System Plan; describes a program management hierarchy; identifies tools available to support management; estimates the number of person-years of technical/engineering support required; mandates a series of specific actions required; and, reports progress on their implementation.
Volume 2: Program Management System (System Description);
Volume 3: Identification and Consolidation of Hierarchy of Documentation;
Volume 4: Level I System Design (to facility level);
Volume 5: Outlines of System Design Levels II, III and IV.

18. Key Words
AVIATION, AIR TRANSPORTATION PLANNING,
CANADIAN AIRSPACE SYSTEMS PLAN

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1. Transport Canada Report No.
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6280/6281

3. Recipient's Catalogue No.

4. Title and Subtitle
CANADIAN AIRSPACE SYSTEMS ENGINEERING PLAN
VOLUME 3: IDENTIFICATION AND CONSOLIDATION OF
HIERARCHY OF DOCUMENTATION

5. Report Date
Avril 1985

6. Performing Organization Report No.
1401

7. Author(s) G. THOMPSON, D. KAN

8. Transport Canada File No.
D1455-164

9. Performing Organization Name and Address

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USA

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11. DSS or Transport Canada Contract No.
OMS84-01253

12. Sponsoring Agency Name and Address

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Le Plan d'aménagement de l'espace aérien du Canada vise à moderniser l'organisation et la gestion de cet espace dont la surveillance fait appel à un nombre très élevé d'installations pour le contrôle de la circulation aérienne et la radionavigation. Ce Plan met en oeuvre un grand nombre d'actions ayant atteint un stade plus ou moins avancé et dont certaines implequent des modifications aux procédures de circulation aérienne ou de vol en vigueur, ou aux normes d'équipement des aéronefs. Pour la réalisation de ce Plan, une approche systémique est préconisée dans ce rapport.
Le rapport comporte cinq parties:
Volume 1: Systems Engineering Management Implementation Plan; ce rapport décrit ou définit: les actions à lancer et les procédés à appliquer en matière de planification; l'ordonnancement général des nombreux éléments du Plan; les liaisons hiérarchiques à établir; les services de soutien au programme de gestion; le tableau estimatif des effectifs techniques à prévoir; et enfin, les progrès accomplis.
Les autres parties traitent plus en details des sujets suivants:
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1.0 INTRODUCTION

The Canadian Airspace Systems Plan is a comprehensive plan for modernizing and improving the Canadian Airspace System. The work envisioned is almost overwhelming in its magnitude. The activities described are so large and complex that they must be addressed in a System Engineering Context if there is to be any hope of successfully implementing the Plan in any reasonable timeframe or at any reasonable cost.

In preparing this Plan for implementing the Canadian Airspace Systems Plan, a number of factors were taken into consideration.

The long term support of the aviation community and the public is important. The continued support of aviation users and the public is likely dependent on delivery of some benefits in terms of enhanced safety, improved services, or reduced operating costs early in the implementation period. Achieving these early benefits will require a very carefully orchestrated integration of project outputs.

There are literally thousands of Air Traffic Control and Air Navigation facilities comprising the Canadian Airspace System. Some are to be retained, others are to be modified, and some are to be replaced. In the aviation community those services cannot be denigrated during implementation activities.

During the life of this program, Operational Performance Requirements will change. These changing requirements will be the result of changes in demand placed on the system or the emergence of changed or new technologies. Provisions must be made in the implementation plan to accommodate these changes even as the Program is moving forward.

The projects comprising the Canadian Airspace Systems Plan are in various stages of implementation. Some are currently being installed in the field, others are in production, others are being planned, and some are yet to be developed. It is almost axiomatic that those activities which are nearest to completion are those which we can change the least (without disrupting the entire activity) and those which are the furthest from completion are more susceptible to change (again without disrupting the entire activity). Although this reality is a significant constraint on any implementation scheme, it must be accommodated.

Implementation of some systems dictate changes in, or alterations to, air traffic procedures, aircraft equipage, or flight procedures.

During every phase of activity, from planning, to design, to implementation, care must be taken to assure that any corresponding air traffic procedures required are practical and will be available. The same is tru of aircraft equipage and flight procedures.

This document identifies and consolidates the hierarchy of documentation needed to guide development of the Canadian Airspace System through its various design levels.

2.0 HIERARCHY OF DOCUMENTATION

1. Canadian Airspace Systems Plan Design Memoranda
2. Levels of Service

(TO BE PROVIDED BY DNR)

3. Operational Requirements

o Air Traffic Services Surveillance Requirements to the Year 2000	TP-3952E
o Flight Data Processing Management	
o Flight Service Stations	
o Control Tower Site and Design Standards	TP-210

(TO BE COMPLETED BY DAT)

4. Canadian Airspace Review	
5. Canadian Airspace Systems Plan	TP-4334E
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Branch Specifications

o Configuration Management	DFS-100X
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o General Specification for Documentation	DFS-1002
o Computer Software Acquisition and Enhancement	DFS-1003
o Specification for Installation of Electronic Equipment by Contract	DFS-1004
o General Specification for Provision of Technical Training Programs	DFS-1006

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o Airport Public Address System	TED-402
o Specification for AGC Speech Amplifier	TAC-3606
o Specification for Airport Public Address System, Wabush Labrador, Newfoundland	TAC-3806
o Specification for Firehall PA System, Halifax International Airport	

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o ASR-3, ASR-5 Radar Antenna Towers	TED-179
o ASR-803 Radar Towers	TED-392
o Design, Manufacture, and Installation of 120 Foot Radar Tower, Toronto	TAR-5000
o Dual VHF Antenna Isolation Equipment	TED-382
o Erection of Steel Towers	TED-338
o Fabrication of Guyed Antenna Towers 80-150' High	TAN-4704
o Fabrication of 168 Ft "T" Antenna	CRC-248
o Four Loop VOR Antenna	CRC-158
o FRP TACAN Antenna Support Cone	CRC-232
o 208 Foot and 300 Foot Guyed Antenna Towers	TAN-4713
o Guyed Antenna Tower 208' Vertical Radiator "Umbrella Loading"	TED-172
o Guyed Antenna Tower 300' Vertical Radiator with "Umbrella Loading"	CRC-106
o Guyed Antenna Towers - 50' to 150' High	RAC-20
o Omni-Directional High Gain VHF Antenna 118 to 152 MHz	TED-270
o Plastic Alford Loop Antenna Shelter Assembly	TED-81
o Radar Antenna Steel Towers ASR-3, ASR-5, and SSR	TED-417
o Radar Antenna Tower for Mobile SSR	TED-398
o Surveillance Radar Antenna Towers (AASR Equipment)	CRC-15
o UHF Antenna 225-440 MHz	TAC-3702

ATC Equipment

o Cornwall Airport Trainer System	TAR-5705
o Leased ATS Operational Telephone System	TAC-3908
o Non-Contacting, Choke Type, Rotary Joint for ATC Beacon Ground System Type CRC/RRB-01	CRC-285
o Solid State Automatic Terminal Information System	TAC-3610

Beacons

o Specification for 1/2/3 KW Solid State LF/MF A2H/A3H Aeronautical Beacon Systems	TAN-4711
o Specification for 100/500 W LF/MF, A2H/A3H Aeronautical Beacon Systems	TAN-4708

Controls (Local, Remote, Control Devices, and Control Systems)

o Integrated Communications Control Systems	TAC-3500
o Modular Communication Control Systems	TED-343
o Navaids Remote Control and Monitoring System	TAN-4705
o Signal, Control and Voice Circuits for Tansmissometer and Ceilometer Installation	CRC-268

Detector and Alarm Systems

o Area Control Centre Emergency Communications System (ACCECS)	TAG-3502
o Airport Access Control System	TAC-3800
o Canadian Airport Security System Access Control Cards and Read Heads	TAC-3808
o Canadian Airport Security System Card Readers	TAC-3809
o Environmental Test Specification for Portable Explosive Detector	TAC-3804
o Portable Explosive Detector	TAC-3802
o Remote Facilities Local Intrusion Alarm System	TAC-3805
o Walk-Through Explosive Detector	TAC-3903

Direction Finders

o VHF Direction Finding System	TAN-4701

Flight Inspection

o Developed of an Inertial Referenced Flight Inspection System	TAN-4800
o Flight Inspection Tracker Telemetry and Corrected-Crosspointer System	TED-389
o Self-contained Aircraft Position Determining Equipment	TAN-4801

ILS and Associated

o Development of Techniques for Identification of Site Features Causing reflection Interference to Instrument Landing Systems	CRC-274
o ILS Equipment	TAN-4901
o Specification for Glide Slope Ground Check Panel	CRC-284
o Specification for ILS Mobile Theodolite Shelter	CRC-28
o Specification for the Overhaul of Mechanical Modulator Glide Path ITT CRC/FRN-1006	TAN-4903
o Vehicle Mounted Crane/Mast	TED-362

Interface Equipment

o Specification for Interface Between Leach Magnetic Tape Unit and Rolm Computer	TED-401
o Specification for Recorder Interface Unit	TAC-3608

Keyers

o Three Letter NDB Keyer	TED-420

Miscellaneous

o General Specifications for Instruction and System Servicing Charts for Fault Diagnosis	TEM-1001
o Aircraft Noie Monitoring System	TAC-3600
o Closed Circuit T.V. Equipment	TAC-3602
o Digital Time Insertion Units	TED-376
o Electronic Clock	TED-336
o Electronic Speech Generator	TAC-3611

o Enclosures Shielded from Electro-Magnetic-Interference	TED-394
o Fire Hall PA System Hamilton Airport	TAC-3614
o Lighting and Ventilation PAR Building	CRC-220
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o Specification for 24 volt DC SUPU	TAC-3709
o Specification for Audio/Visual Information System Toronto International Airport	TAC-3603
o Specification for Headset and Handset	TAC-3604
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o VHF-DF Trainer for Air Traffic Services and Telecommunications Operations Training	TAR-5706
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o X-Ray Detection Equipment (Confidential)	TED-415

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o AASR-1 System Overhaul	TEM-513
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o Overhaul of RCA GP Mechanical Modulator	TEM-502
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Radar and Radar Associated

o Airport Surface Detection ASDE Radar	TAR-5505
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o UHF/FM Based Mobile Radio Systems	TED-384
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o HF Transmitters	TAC-3707
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FOREWORD

This document, the Canadian Airspace Systems Plan - Level One Design, outlines the basic integrated system design to meet the Canadian Aviation requirements to the year 2000. It provides the first level of identification and specification of the basic elements of the system, the associated facility groupings and the the data flows and interfaces. This document is the first of four levels of technical design that ultimately will define the telecommunications network and electronics equipment for each site. As such, it provides the basis for the second level design which will define the topology, interfaces, performance characteristics distributions, and sizing and inter-connectivity of all sites.

As the system design progresses to greater and greater detail, it will be necessary to review and revise the basic design decisions. Therefore, this document will be periodically revised utilizing a controlled design change process.

This Level One System Design, in addition to providing the basic technical system design for the Canadian Airspace System for an integrated systems approach to implementing the plan, will also provide to users and to industry the basic concepts for the airspace system in the future.

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4.1.2 Independent Secondary Surveillance

4.1.3 Airport Surface Detection

4.1.4 Weather Radar

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4.2.4 Satellite Communications

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4.3.5.1 Very High Frequency Omni-Range Test (VOT)
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5.1.1.1 Control Centre Computer
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5.1.3 Carrier
5.1.3.1 Carrier Equipment
5.1.4 Remote Interface
5.1.4.1 Remote Interface Equipment
5.1.5 Direct Access User Terminal (DUAT)
5.1.5.1 Direct User Access Terminal Equipment

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6.1.1.1 National Maintenance Centre Processor (NMCP)
6.1.2 Regional Maintenance Centre (RMC)
6.1.2.1 Regional Maintenance Centre Processor (RMCP)
6.1.3 Area Maintenance Centre (AMC)
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6.1.4.1 Site Multiplexer (SM)
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6.2.1.1 Power Transfer Equipment
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6.3.1.1 Computer Based Instruction Systems
6.3.1.2 Area Control Centre Training Simulator
6.3.1.3 Termincal Control Unit Training Simulator
6.3.1.4 Control Tower Training Simulator
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6.3.1.6 Navigational Aids Training Simulator
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6.3.1.8 Communications Systems Training Simulator
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6.3.1.10 Aircraft Avionics Training Simulator
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6.3.2 Regional Air Traffic Training Facility
6.3.2.1 Area Control Centre Training Simulator
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6.3.2.4 Record, Playback, and Display Systems
6.3.3 Regional Flight Service Training Facility
6.3.3.1 Flight Service Station Training Simulator
6.3.3.2 Record, Playback, and Displasy Systems
6.3.4 Regional Facilities Engineering and Systems Development Training Facility
6.3.4.1 Maintenance Control Centre Training Simulator
6.3.4.2 Navigational Aids Training Simulator
6.3.4.3 Radar Systems Training Simulator
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6.4.1 Test and Evaluation Centre
6.4.1.1 Model Shop
6.4.1.2 Printed Wiring Board Facility
6.4.1.3 Wiring and Assembly Facility
6.4.1.4 Standards Facility
6.4.1.5 Computing Facility
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6.4.2.4 Common Controller and Flight Service Station Workstation
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6.4.2.6 Visual Tower Simulator
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6.5.1 Airborne Flight Inspection Facility
6.5.1.1 Digital Flight Inspection System (DFIS)
6.5.1.2 Self Contained Aircraft Positioning Equipment (SCAPE)
6.5.2 Ground Flight Inspection Support Facility
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CANADIAN AIRSPACE SYSTEM

INTRODUCTION AND OVERVIEW

1.0 INTRODUCTION

PURPOSE

The Canadian Airspace System, System Design, Level One defines and sets forth the Canadian Airspace System Elements, Facilities, and Equipment as well as their interfaces. This document serves as the basis for the overall design and modernization of the Canadian Airspace System. It is the first of several System Design documents that are designed to provide a measure of control in the overall design and planning processes for the Modernization of the Canadian Airspace System and the Canadian Airspace Systems Plan.

BACKGROUND

This document has been prepared to meet the objectives of the Canadian Airspace Systems Plan and to establish a systems level approach to implementing the Plan. The objectives of the Level One System Design are to provide for high functional availability and reliability of facilities; cost and manpower effective designs; minimal complexity and maximum modularity, commonality, and standardization; flexible and expandable designs maximizing network interfacing and the use of a common National Network and remote maintenance monitoring and control.

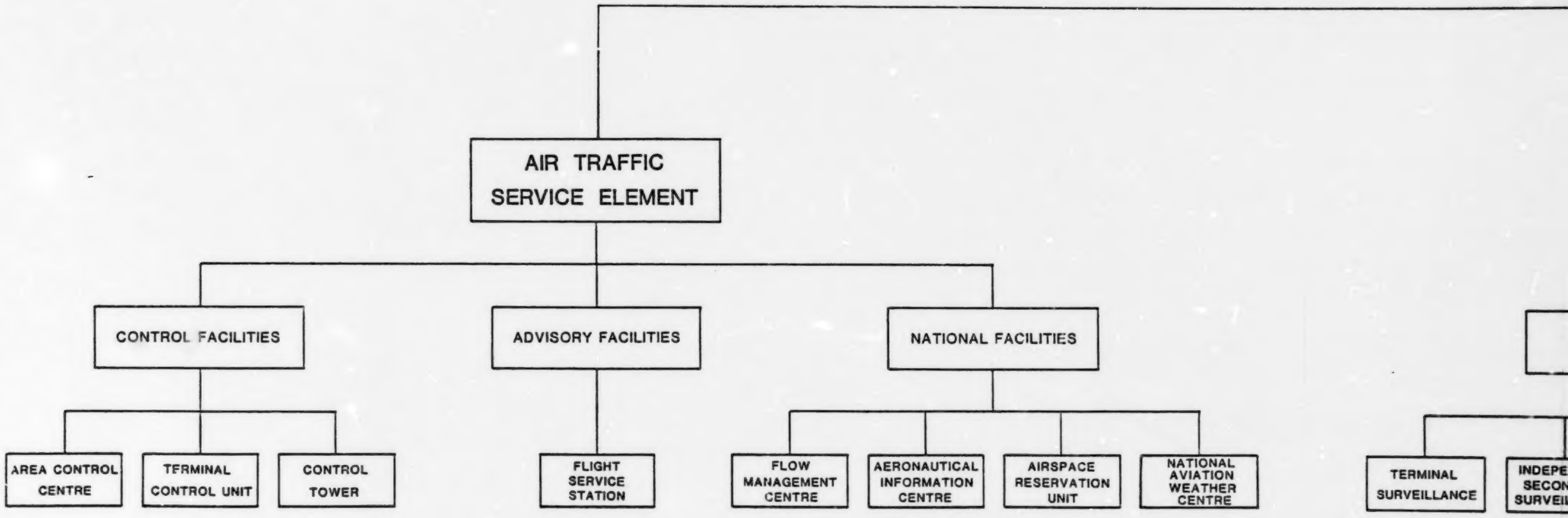
SCOPE

The Level One System Design is a qualitative high level system definition. It identifies the allocation of functions to specific facilities and equipment. It describes the associated interfaces and outlines the data flow across each one.

Subsequent levels of design will address system topology, quantity, location, connectivity, performance requirements, implementation timing, engineering requirements, and site packages.

2.0 OVERVIEW

For ease of review and comprehension, the Canadian Airspace System has been divided into four major elements; Air Traffic Services, Ground-To-Air, Interfacility Telecommunications, and Maintenance, Technical and Support. These elements are further subdivided into facilities. The word "facility" as used in this document describes a unique colocated grouping of equipment that performs a common function. The Air Traffic Service Element is comprised of Control Facilities, Advisory Facilities, and National Facilities. The Ground-To-Air Element, which also includes air-to-ground, is comprised of Surveillance Facilities, Communication Facilities, Navigation Facilities, and Weather Sensor Facilities. The Interfacility Telecommunications Element contains all Interconnect Facilities. The Maintenance, Technical, and Support Element is comprised of Maintenance Facilities, Environmental Facilities, Training Facilities, Research and Development Facilities, and Flight Inspection Facilities. Figure 2-1 depicts the complete design partitioning and breakdown.


AIR TRAFFIC SERVICE ELEMENT
CONTROL FACILITIES
ADVISORY FACILITIES
NATIONAL FACILITIES
AREA CONTROL CENTRE
TERMINAL CONTROL UNIT
CONTROL TOWER
FLIGHT SERVICE STATION
FLOW MANAGEMENT CENTRE
AERONAUTICAL INFORMATION CENTRE
AIRSPACE RESERVATION UNIT
NATIONAL AVIATION WEATHER CENTRE
TERMINAL SURVEILLANCE
INDEPE
SECON
SURVEIL

OVERVIEW

LEVEL I SYSTEM DESIGN

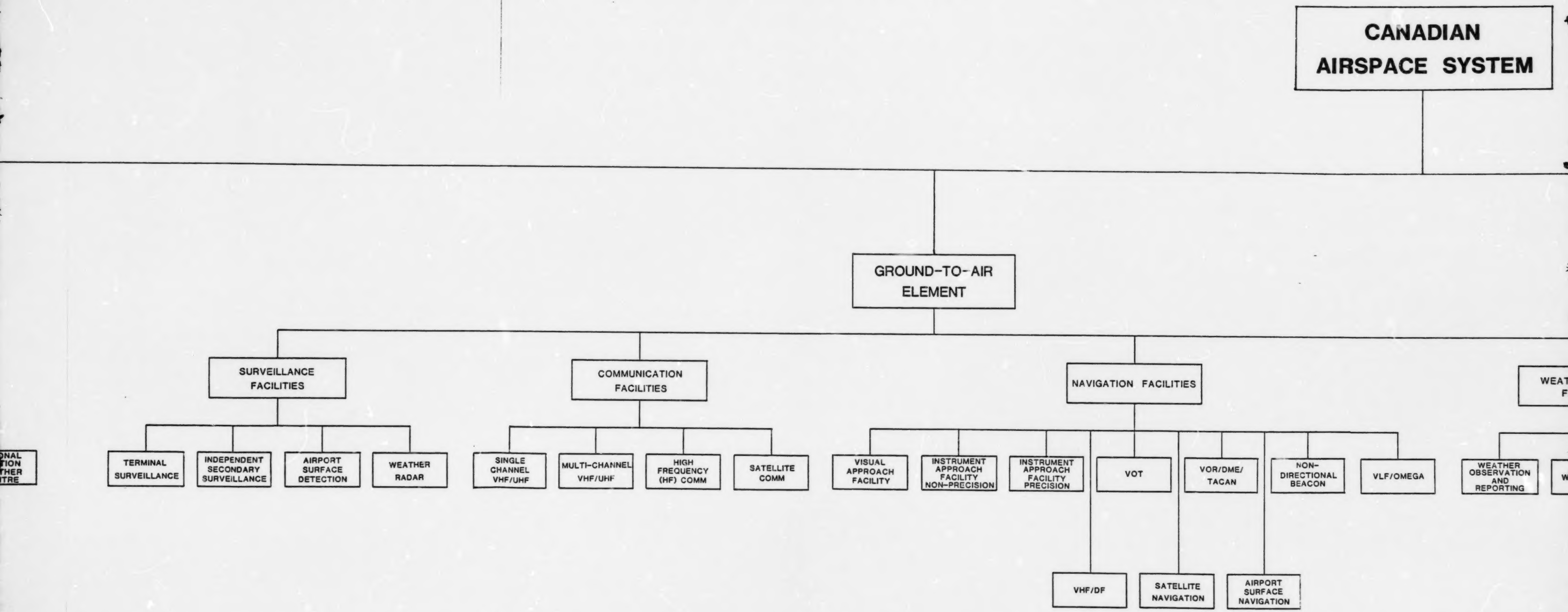

CANADIAN AIRSPACE SYSTEM
GROUND-TO-AIR ELEMENT
SURVEILLANCE FACILITIES
COMMUNICATION FACILITIES
NAVIGATION FACILITIES
TERMINAL SURVEILLANCE
INDEPENDENT SECONDARY SURVEILLANCE
AIRPORT SURFACE DETECTION
WEATHER RADAR
SINGLE CHANNEL VHF/UHF
MULTI-CHANNEL VHF/UHF
HIGH FREQUENCY (HF) COMM
SATELLITE COMM
VISUAL APPROACH FACILITY
INSTRUMENT APPROACH FACILITY NON-PRECISION
INSTRUMENT APPROACH FACILITY PRECISION
VOT
VOR/DME/ TACAN
NON-DIRECTIONAL BEACON
VLF/OMEGA
VHF/DF
SATELLITE NAVIGATION
AIRPORT SURFACE NAVIGATION
WEATHER OBSERVATION AND REPORTING

FIGURE 2—1

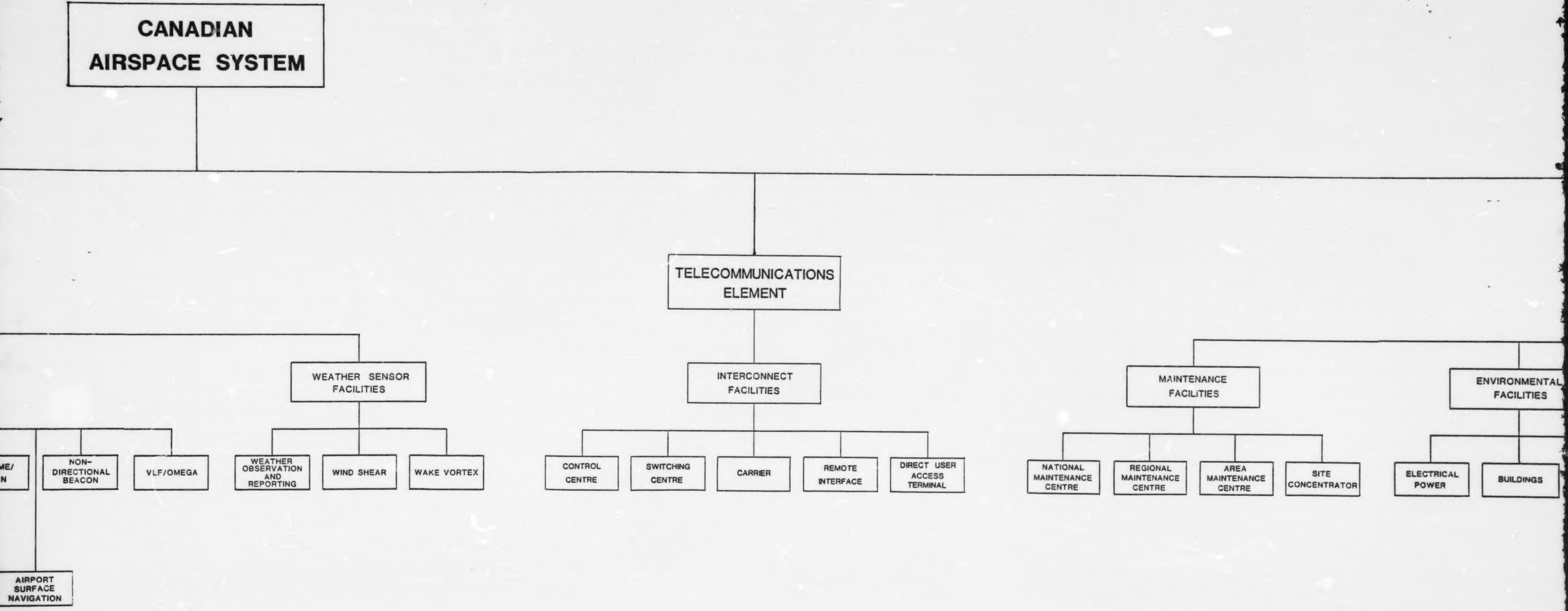
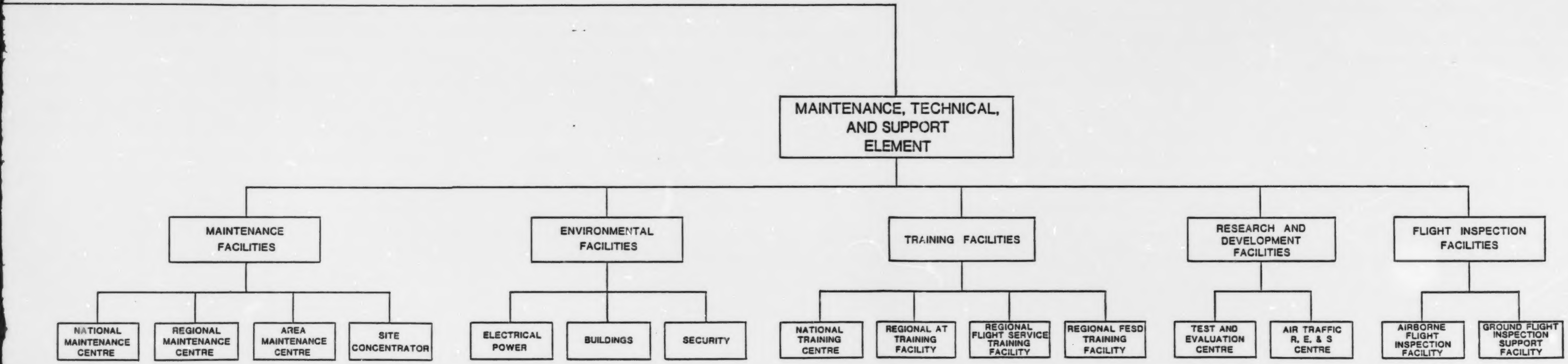

CANADIAN AIRSPACE SYSTEM
TELECOMMUNICATIONS ELEMENT
WEATHER SENSOR FACILITIES
INTERCONNECT FACILITIES
MAINTENANCE FACILITIES
ENVIRONMENTAL FACILITIES
ME/
N
NON-DIRECTIONAL BEACON
VLF/OMEGA
AIRPORT SURFACE NAVIGATION
WEATHER OBSERVATION AND REPORTING
WIND SHEAR
WAKE VORTEX
CONTROL CENTRE
SWITCHING CENTRE
CARRIER
REMOTE INTERFACE
DIRECT USER ACCESS TERMINAL
NATIONAL MAINTENANCE CENTRE
REGIONAL MAINTENANCE CENTRE
AREA MAINTENANCE CENTRE
SITE CONCENTRATOR
ELECTRICAL POWER
BUILDINGS

FIGURE 2—1


MAINTENANCE, TECHNICAL, AND SUPPORT ELEMENT
MAINTENANCE FACILITIES
ENVIRONMENTAL FACILITIES
TRAINING FACILITIES
RESEARCH AND DEVELOPMENT FACILITIES
FLIGHT INSPECTION FACILITIES
NATIONAL MAINTENANCE CENTRE
REGIONAL MAINTENANCE CENTRE
AREA MAINTENANCE CENTRE
SITE CONCENTRATOR
ELECTRICAL POWER
BUILDINGS
SECURITY
NATIONAL TRAINING CENTRE
REGIONAL AT TRAINING FACILITY
REGIONAL FLIGHT SERVICE TRAINING FACILITY
REGIONAL FESD TRAINING FACILITY
TEST AND EVALUATION CENTRE
AIR TRAFFIC R, E, & S CENTRE
AIRBORNE FLIGHT INSPECTION FACILITY
GROUND FLIGHT INSPECTION SUPPORT FACILITY

CANADIAN AIRSPACE SYSTEM

AIR TRAFFIC SERVICE ELEMENT

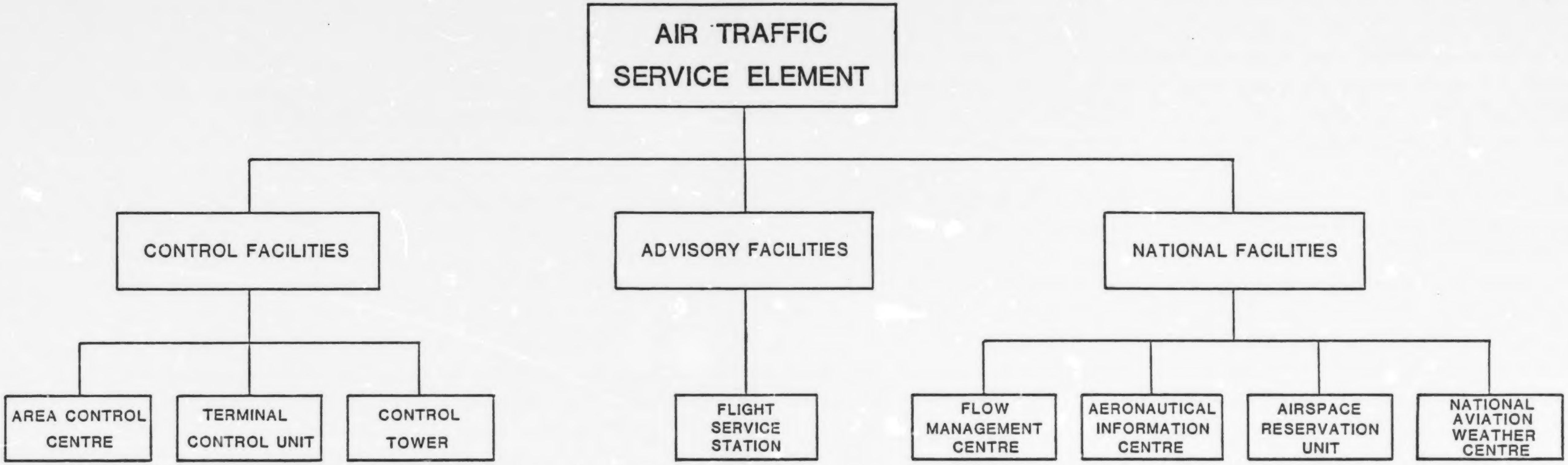
3.0 AIR TRAFFIC SERVICE ELEMENT

The Air Traffic Service Element consists of Control Facilities, Advisory Facilities, and National Facilities and includes the systems, subsystems, and equipment that provide and process electronic and voice data for air traffic control purposes.

Control Facilities are comprised of Area Control Centres, Terminal Control Units, and Control Towers. These facilities provide local and regional air traffic control and advisory services for all domestic users and in certain geographic areas provide support to satisfy requirements of international users.

Advisory Facilities are represented by Flight Service Stations that provide local and regional advisory services for domestic users and in certain geographic areas provide advisory services to international users.

National Facilities are made up of the Flow Management Centre, the Aeronautical Information Centre, the Airspace Reservation Unit, and the National Aviation Weather Centre. These facilities provide operational services at the national level for flow management support through centralized collection, processing, and dissemination facilities.


AIR TRAFFIC SERVICE ELEMENT
CONTROL FACILITIES
ADVISORY FACILITIES
NATIONAL FACILITIES
AREA CONTROL CENTRE
TERMINAL CONTROL UNIT
CONTROL TOWER
FLIGHT SERVICE STATION
FLOW MANAGEMENT CENTRE
AERONAUTICAL INFORMATION CENTRE
AIRSPACE RESERVATION UNIT
NATIONAL AVIATION WEATHER CENTRE

AIR TRAFFIC SERVICE ELEMENT

FIGURE 3-1

3.1 CONTROL FACILITIES

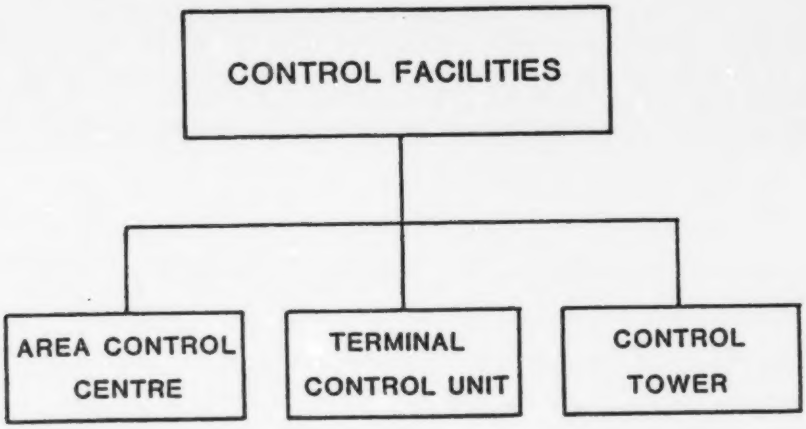

CONTROL FACILITIES
AREA CONTROL CENTRE
TERMINAL CONTROL UNIT
CONTROL TOWER

FIGURE 3-2

DESCRIPTION

Control Facilities provide local and regional air traffic control, advisory, and alerting services to users within well defined geographic boundaries for arrival, departure, enroute, and airport surface traffic.

3.1.1 AREA CONTROL CENTRE

PURPOSE

The Area Control Centre (ACC) is responsible for providing control, advisory, and alerting services within a designated airspace known as a Flight Information Region (FIR). Within this defined volume of airspace the ACC will provide enroute, approach, and departure control for aircraft requesting separation assurance services.

FUNCTION

The following descriptions are the major functions of an Area Control Centre.

Flight Data Processing is the automated acquisition, processing, and transfer of data regarding the actual and intended movements of aircraft. This data can be in the form of flight plans, control messages, or positional information. Utilizing these inputs the processor will construct and maintain a dynamic air traffic model from which it will search for potential conflicts and attempt to resolve the conflicts based on variable separation criteria. This processing also applies to non-radar areas such as the Northern Airspace and Oceanic Airspace as well as airspace within radar coverages.

The processor's data base will also calculate and provide conflict free and optimum fuel efficient profiles to all who use automated flight plan filing.

Data Display Processing is the acquisition of data to be displayed from the surveillance data, flight data, weather data, and aeronautical information processing systems. Based on air traffic controller inputs and settings (via interactive input devices), the data will be presented on the appropriate output device(s), such as CRT terminals and printers, at the Common Controller Workstation.

Weather Data Processing within the Area Control Centre is the collection and processing of current and forecasted weather conditions so as to enable accurate time/distance calculations pertaining to the planned and actual flight of all aircraft through the Flight Information Region. In addition, selected weather products will be provided to all users.

Operational Reconfiguration is the functional capability to automatically reconfigure all processing and display functions when the Area Control Centre is operationally reconfigured for special situations or other operational requirements.

Surveillance Data Processing is the correllation of air traffic position coordinates and identity codes to flight plan data to produce a "best" track for each aircraft which is maintained (while in the jurisdiction area) and formatted for transfer to the Data Display System.

Mode S data link messages are also received and preprocessed for transfer to the appropriate colocated equipment or facility.

Conflict prediction, resolution advisory, and minimum safe altitude warning tasks will be performed within the Surveillance Data Processing function.

Common Time Distribution is the acquisition and distribution of a common reference time source to ensure the synchronization of all independent systems.

Regional Air Traffic Control Simulation is the ability to simulate the actual operation of the parent Area Control Centre to provide efficiency evaluations and training of controllers in a duplicate operational environment. Terminal Control Unit simulations will also be provided and conducted at this facility.

Additionally, this facility will also include the capability to reproduce recorded air traffic control events.

Communications Switching is a communications bank that handles all voice and data inputs and outputs and is capable of providing full flexibility in communications reconfigurations.

Aeronautical Information Processing provides a national and selected international storage of current aeronautical information such as airport approach procedures, airways, restricted areas, Notices to Airmen (NOTAMS), airport conditions, and equipment operational status'. This information will be disseminated to all air traffic service and user access terminals.

Recording is the function of providing and storing all information that enables the reproduction of the total air traffic situation as it occurred in any point in time. This reproduction capability will be made available at the site, Regional Air Traffic Simulation Facility, as well as at national facilities (RESC, TSC, TCTI). This information will include the dynamic air traffic situation, communications, all displays, weather, and aeronautical information.

Flow Management provides predicted and real-time flow restriction information and airspace reservation information for flight planning as well as for adjusting in-flight profiles to minimize conflict causing delays and to allow fuel efficient operations.

The Flow Management process will be based on a number of dynamic variables such as airport acceptance rates, sector workload limits, weather, navigational aids status', and airspace reservations. Where congestion or workload limits approach capacity, recommended routes, altitudes, or departure and arrival times will be transmitted to appropriate locations for action.

The capability of traffic metering will also be incorporated and will be provided when airborne and ground stations are capable of ground-air-ground data linking (Mode S, HF/VHF data links).

Operational Statistics Analysis and Accumulation will provide Transport Canada with all necessary statistics for cost recovery from users as well as monitoring sector and workstation workloads, system utilization, and airspace utilization for efficient system management.

AREA CONTROL CENTRE

FUNCTIONAL INPUTS				
FROM	LOC	NAME	STANDARD	LOC
AIRLINES		Flt Pln	ICAO4444	
ACC		Flt Pln	ICAO4444	
TCU		Flt Pln	ICAO4444	
TWR		Flt Pln	ICAO4444	
FSS		Flt Pln	ICAO4444	
GANDFSS		Flt Pln	ICAO4444	
DUAT		Flt Pln	ICAO4444	
PRIVDUAT		Flt Pln	ICAO4444	
NONTCFAC		Flt Pln	ICAO4444	
AVWXCTR		Wx Sat		
AVWXCTR		Wx Radar		
TSR		Wx Radar		
WXRADAR		Wx Radar		
AVWXCTR		Now Wx		
AWORS		Now Wx		
TCU		SIGMETS		
TWR		SIGMETS		
AVWXCTR		SIGMETS		
ACC		Flow Mgmt		
TCU		Flow Mgmt		
NONTCFAC		Flow Mgmt		
FLOCOCTR		Flow Mgmt		
TCU		Wx Request		
TWR		Wx Request		
FSS		Wx Request		
GANDFSS		Wx Request		
DUAT		Wx Request		
PRIVDUAT		Wx Request		
TCU		AIP Req		
TWR		AIP Req		
FSS		AIP Req		
GANDFSS		AIP Req		
DUAT		AIP Req		
PRIVDUAT		AIP Req		
AIPCTR		AID Base		
FSS		NOTAMS		
GANDFSS		NOTAMS		
AIPCTR		NOTAMS		
RMTCECTR		Equip Stat		
ACC		ATC Comm		
TCU		ATC Comm		
TWR		ATC Comm		
FSS		ATC Comm		
GANDFSS		ATC Comm		
NONTCFAC		ATC Comm		

FACILITY PRINCIPAL FUNCTIONS		
REQUIREMENT	DESCRIPTION	SPECIFICATION
	Surveillance Data Processing	
	Flight Data Processing	
	Display Processing	
	Weather Data Processing and Distribution	
	Common Time Distribution	
	Regional ATC Simulation	
	Communication Switching	
	Aeronautical Information Processing	
	Recording	
	Flow Management	
	Operational Statistics Analysis (Off-Line) and Accumulation	
	Operational Reconfigurations	

FUNCTIONAL OUTPUTS				
LOC	NAME	STANDARD	TO	LOC
	Flt Pln	ICAO4444	AIRLINES	
	Flt Pln	ICAO4444	ACC	
	Flt Pln	ICAO4444	TCU	
	Flt Pln	ICAO4444	TWR	
	Flt Pln	ICAO4444	FSS	
	Flt Pln	ICAO4444	GANDFSS	
	Flt Pln	ICAO4444	DUAT	
	Flt Pln	ICAO4444	PRIVDUAT	
	Flt Pln	ICAO4444	NONTCFAC	
	Wx Sat		TCU	
	Wx Sat		TWR	
	Wx Sat		FSS	
	Wx Sat		GANDFSS	
	Wx Sat		DUAT	
	Wx Sat		PRIVDUAT	
	Wx Radar		TCU	
	Wx Radar		TWR	
	Wx Radar		FSS	
	Wx Radar		GANDFSS	
	Wx Radar		DUAT	
	Wx Radar		PRIVDUAT	
	Wx Radar		AVWXCTR	
	Now Wx		TCU	
	Now Wx		TWR	
	Now Wx		FSS	
	Now Wx		GANDFSS	
	Now Wx		DUAT	
	Now Wx		PRIVDUAT	
	Now Wx		AVWXCTR	
	SIGMETS		TCU	
	SIGMETS		TWR	
	SIGMETS		FSS	
	SIGMETS		GANDFSS	
	SIGMETS		DUAT	
	SIGMETS		PRIVDUAT	
	SIGMETS		AVWXCTR	
	Flow Mgmt		ACC	
	Flow Mgmt		TCU	
	Flow Mgmt		TWR	
	Flow Mgmt		F; PCPCTR	
	Aero Info		TCI	
	Aero Info		TWR	
	Aero Info		FSS	
	Aero Info		GANDFSS	
	Aero Info		DUAT	
	Aero Info		PRIVDUAT	

FIGURE 3-3

AREA CONTROL CENTRE

FUNCTIONAL INPUTS

FROM	LOC	NAME	STANDARD	LOC
ACC		Handoff DA		
TCU		Handoff DA		
TWR		Handoff DA		
NONTCFAC		Handoff DA		
FSS		Psn Rpt VC		
GANDFSS		Psn Rpt VC		
PRIVDUAT		Psn Rpt VC		
HFCOM		Psn Rpt DA		
SATCOM		Psn Rpt DA		
NONTCFAC		Psn Rpt RA		
TSR		Psn Rpt RA		
ISSR		Psn Rpt RA		
SINGLCOM		ATCComm AG		
MULTICOM		ATCComm AG		
TSR		Clr Req DA		
ISSR		Clr Req DA		
HFCOM		Clr Req DA		
SATCOM		Clr Req DA		
TSR		PIREPS DA		
ISSR		PIREPS DA		
HFCOM		PIREPS DA		
SATCOM		PIREPS DA		
TSR		Emgcy Msg		
ISSR		Emgcy Msg		
SINGLCOM		Distrs Msg		
MULTICOM		Distrs Msg		
HFCOM		SAR Req DA		
HFCOM		SAR Req DA		
SATCOM		SAR Req DA		

FACILITY
PRINCIPAL FUNCTIONS

REQUIREMENT	DESCRIPTION	SPECIFICATION

EQUIPMENT TYPES

- Central Computer Complex
- Communications Control System
- Flight Data Processing System
- Common Controller Work Stations
- Surveillance Data Processing System
- Aeronautical Info Processing System
- Weather Data Processing System
- Uninterruptible Power System

FUNCTIONAL OUTPUTS

LOC	NAME	STANDARD	TO	LOC
	NOTAMS		TCU	
	NOTAMS		TWR	
	NOTAMS		FSS	
	NOTAMS		GANDFSS	
	NOTAMS		DUAT	
	NOTAMS		PRIVDUAT	
	Equip Stat		RMTCECTR	
	ATC Comm		ACC	
	ATC Comm		TCU	
	ATC Comm		TWR	
	ATC Comm		NONTCFAC	
	ATC Comm		SINGLCOM	
	ATC Comm		MULTICOM	
	Handoff DA		ACC	
	Handoff DA		TCU	
	Handoff DA		TWR	
	Handoff DA		NONTCFAC	
	Psn Rpt Rq		HFCOM	
	Psn Rpt Rq		SATCOM	
	D/L Msg		TSR	
	D/L Msg		ISSR	
	Clr Del DA		HFCOM	
	Clr Del DA		SATCOM	
	PIREPS		AVWXCTR	
	SAR Data		NONTCFAC	
	PushToTalk		SINGLCOM	
	PushToTalk		MULTICOM	
	Time Sync		TCU	
	Time Sync		TWR	
	Time Sync		FSS	
	Time Sync		GANDFSS	
	Aires Apvl		AIRLINES	
	Aires Apvl		ACC	
	Alert		NONTCFAC	
	AdvCustoms		AIRLINES	
	AdvCustoms		NONTCFAC	
	Statistics		NONTCFAC	

FIGURE 3-3 (CONTINUED)

3.1.1.1 Central Computer Complex (CCC)

PURPOSE

The Central Computer Complex (CCC) provides the Area Control Centre with a central processing system that automatically collects, process, and disseminates all flight data to allow the air traffic controller to maintain the orderly and efficient flow of air traffic.

FUNCTION

The Central Computer Complex (CCC) will provide all the CPU and system control functions as well as high speed storage and printing facilities. The CCC's primary functions include primary processing, data entry and display, monitor and control, emergency processing, support and training, and diagnostics and repair.

3.1.1.2 Communications Control System (CCS)

Communications control will be handled by a common network and controller for the facility.

PURPOSE

The Communications Control System (CCS) provides the intrafacility voice links as well as the interfacility and ground-air communications interface.

FUNCTION

The functions of the Communications Control System (CCS) includes direct switching, trunking, configuration and reconfiguration, internal diagnostics, redundancy, and transaction recording.

3.1.1.3 Flight Data Processing System (FDPS)

PURPOSE

The Flight Data Processing System (FDPS) provides automatic and timely processing and transfer of flight data including estimates of flight times, conflict probe and resolution, automatic generation of air traffic control clearances, data for strategic flow management, and statistics data between all air traffic facilities and airline operations offices.

FUNCTION

The principal data inputs to an air traffic control system are flight data and radar data.

Flight data originating from flight plans, termed flight plan data, is all that data supplied to an air traffic control system by an aircraft operator, either before or during flight, which concerns the intended or actual movement of an aircraft.

Processing is defined as "a course of action" or "series of operations" and thus flight plan processing is the sequence of events whereby the intentions of each aircraft participating in the air traffic control system are entered into the air traffic control system, recorded, formatted, displayed, and disposed of by the air traffic control system.

The content and format of flight plans is embodied in published flight plan forms and the circumstances under which operators may or must file flight plans are contrained in the Canadian Aeronautical Information Publication (AIP).

Air traffic control system formatting of flight plan data currently consists of extracting specific items of data and transferring them onto flight progress strips as "control data".

Control data is the essential information used by the air traffic controller to build and update his visualization of dynamic air traffic scenarios thereby constituting tangible representation of the otherwise unseen changing locations of aircraft.

Disposal of flight plan data by the air traffic control system takes two forms. First, unless the flight terminates with the particular air traffic control unit, as a data transfer (transfer of control) to an adjoining air traffic control unit. Secondly, flight plan data is disposed of into records which have further use as potential evidence in accident or incident investigations, as search and rescue input data, and as statistical data for system support, user billing, and general statistical purposes.

3.1.1.4 Surveillance Data Processing System (SDPS)

PURPOSE

The Surveillance Data Processing System (SDPS) provides for all surveillance data processing, including dependent and independent reporting, for the Area Control Centre.

FUNCTION

The functions of the Surveillance Data Processing System (SDPS) include centralized processing for surveillance data received from enroute, terminal, and Mode S sensors, automatic tracking, data entry and display, and diagnostics and repair.

3.1.1.5 Aeronautical Information Processing System (AIPS)

PURPOSE

The Aeronautical Information Processing System (AIPS) will be the local data base for the Area Control Centre to provide essential aeronautical information on a timely basis to all air traffic facilities, pilots, and aircraft operations offices.

FUNCTION

The principal functions of the Aeronautical Information Processing System (AIPS) includes provisions for real time sensor derived data, data entry and display, high speed storage, and on line access for non real time data.

3.1.1.6 Weather Data Processing System (WDPS)

PURPOSE

The Weather Data Processing System (WDPS) provides the computational capability needed to produce the weather products used by the Area Control Centre

FUNCTION

The primary functions of the Weather Data Processing System (WDPS) is to collect and process all the weather information required for the Area Control Centre operation and process it to meet the needs of other Area Control Centre systems. As well, it will forward information to be used by adjacent Area Control Centres and the national system.

3.1.1.7 Common Controller Workstations (CCWS)

PURPOSE

The Common Controller Workstation (CCWS) will be an integrated and versatile sector suite with the capability of being operated by one controller and will consist of an operating position and a workstation processor. The operating position will be a modular, ergonomically designed control and display position with tactile input devices, high resolution display devices, and auditory output and input systems. The work station processor will interface to the network and will be operator configurable to meet the particular position requirements.

FUNCTION

The principal functions of the Common Controller Workstation (CCWS) are to provide electronic displays of digital radar data, flight plan data, weather data, and supplementary aeronatuical information and provide for raw data processing in the event of loss of computed data from a central processing function.

3.1.1.8 Uninterruptible Power System (UPS)

PURPOSE

The Uninterruptible Power System (UPS) will provide a backup to the primary power feed to maintain the minimum allowable system configuration that will provide the essential Area Control Centre functions.

3.1.2 TERMINAL CONTROL UNIT

PURPOSE

The Terminal Control Unit (TCU) is responsible for providing control, advisory, and alerting services within controlled airspace of defined dimensions designated to serve arriving, departing, and enroute aircraft. This airspace is defined as a Terminal Control Area (TCA) and will provide enroute, approach, and departure control for aircraft requesting separation assurance services.

FUNCTION

The following descriptions are the major functions of a Terminal Control Unit.

Flight Data Processing in Terminal Control Units is a function limited to accepting flight plan data information from Area Control Centers and performing processing that is required only for internal transfer and its associated Control Tower(s). The capability to manually enter flight plans or acquire them from a bulk storage file in the event of a communications failure with the Area Control Center will also be provided.

Data Display Processing is the acquisition of data to be displayed from the surveillance data, flight data, weather data, and aeronautical information processing systems. Based on air traffic controller inputs and settings (via interactive input devices), the data will be presented on the appropriate output device(s), such as CRT terminals and printers, at the Common Controller Workstation.

Weather Data Processing within the Terminal Control Unit is the collection and processing of current and forecasted weather conditions so as to enable accurate time/distance calculations pertaining to the planned and actual flight of all aircraft through the Terminal Control Area. In addition, selected weather products will be provided to all users.

Operational Reconfiguration is the functional capability to automatically reconfigure all processing and display functions when the Terminal Control Unit is operationally reconfigured for special situations or other operational requirements.

Surveillance Data Processing is the correllation of air traffic position coordinates and identity codes to flight plan data to produce a "best" track for each aircraft which is maintained (while in the jurisdiction area) and formatted for transfer to the Data Display System.

Mode S data link messages are also received and preprocessed for transfer to the appropriate colocated equipment or facility.

Conflict prediction, resolution advisory, and minimum safe altitude warning tasks will be performed within the Surveillance Data Processing function.

Common Time Distribution is the acquisition and distribution of a common reference time source to ensure the synchronization of all independent systems.

Communications Switching is a communications bank that handles all voice and data inputs and outputs and is capable of providing full flexibility in communications reconfigurations

Aeronautical Information Processing provides a national and selected international storage of current aeronautical information such as airport approach procedures, airways, restricted areas, Notices to Airmen (NOTAMS), airport conditions, and equipment operational status'. This information will be disseminated to all air traffic service and user access terminals.

Recording is the function of providing and storing all information that enables the reproduction of the total air traffic situation as it occurred in any point in time. This reproduction capability will be made available at the site, Regional Air Traffic Simulation Facility, as well as at national facilities (RESC, TSC, TCTI). This information will include the dynamic air traffic situation, communications, all displays, weather, and aeronautical information.

Operational Statistics Analysis and Accumulation will provide Transport Canada with all necessary statistics for cost recovery from users as well as monitoring sector and workstation workloads, system utilization, and airspace utilization for efficient system management.

TERMINAL CONTROL UNIT

FUNCTIONAL INPUTS				
FROM	LOC	NAME	STANDARD	LOC
ACC		Flt Pln	ICAO4444	
ACC		Wx Sat		
ACC		Wx Radar		
TSR		Wx Radar		
WXRADAR		Wx Radar		
ACC		Now Wx		
ACC		Fcst Wx		
ACC		SIGMETS		
ACC		Flow Mgmt		
SINGLCOM		Wx Request		
MULTICOM		Wx Request		
SINGLCOM		AIP Req		
MULTICOM		AIP Req		
ACC		AID Base		
ACC		NOTAMS		
RMTCECTR		Equip Stat		
ACC		ATC Comm		
TWR		ATC Comm		
NONTCFAC		ATC Comm		
ACC		Handoff DA		
TWR		Handoff DA		
ACC		Handoff DA		
TWR		Handoff DA		
SINGLCOM		ATC Comm		
MULTICOM		ATC Comm		
TSR		PIREPS DA		
ISSR		PIREPS DA		
HFCOM		PIREPS DA		
SATCOM		PIREPS DA		
SINGLCOM		Distrs Msg		
MULTICOM		Distrs Msg		
ACC		Time Sync		
TSR		Emergency		
ISSR		Emergency		

FACILITY PRINCIPAL FUNCTIONS		
REQUIREMENT	DESCRIPTION	SPECIFICATION
	Surveillance Data Processing	
	Flight Data Processing	
	Display Processing	
	Weather Data Processing and Distribution	
	Common Time Distribution	
	Communication Switching	
	Aeronautical Information Processing	
	Recording	
	Operational Statistics Analysis (Off-Line) and Accumulation	
	Operational Reconfigurations	

FUNCTIONAL OUTPUTS				
LOC	NAME	STANDARD	TO	LOC
	Flt Pln	ICAO4444	ACC	
	SIGMETS		ACC	
	Flow Mgmt		ACC	
	Aero Info		ACC	
	NOTAMS		ACC	
	Equip Stat		RMTCECTR	
	ATC Comm		ACC	
	ATC Comm		TWR	
	ATC Comm		NONTCFAC	
	Handoff DA		ACC	
	Handoff DA		TWR	
	Handoff DA		NONTCFAC	
	D/Link Msg		TSR	
	D/Link Msg		ISSR	
	ATCCom AG		SINGLCOM	
	ATCCom AG		MULTICOM	
	PIREPS		AVWXCTR	
	PushToTalk		SINGLCOM	
	PushToTalk		MULTICOM	
	Statistics		ACC	
	SAR VC		ACC	

EQUIPMENT TYPES	
o Central Computer Complex	o Interfacility Communications System
o Communications Control System	o Common Controller Work Stations
o Radar Data Processing System	o
	o

FIGURE 3-4

3.1.2.1 Central Computer Complex (CCC)

PURPOSE

The Central Computer Complex (CCC) provides the Terminal Control Unit with a central processing system that automatically collects, process, and disseminates all flight data to allow the air traffic controller to maintain the orderly and efficient flow of air traffic within the Terminal Control Area or Control Zone.

FUNCTION

The Central Computer Complex (CCC) will provide all the CPU and system control functions as well as high speed storage and printing facilities. The primary functions of the CCC includes primary processing, data entry and display, monitor and control, emergency processing, support and training, and diagnostics and repair.

3.1.2.2 Communications Control System (CCS)

Communications control will be handled by a common network and controller for the facility.

PURPOSE

The Communications Control System (CCS) provides the intrafacility voice links as well as the interfacility and ground-air communications interface.

FUNCTION

The functions of the Communications Control System (CCS) includes direct switching, trunking, configuration and reconfiguration, internal diagnostics, redundancy, and transaction recording.

3.1.2.3 Radar Data Processing System (RDPS)

PURPOSE

The Radar Data Processing System (RDPS) provides for all surveillance data processing, including dependent and independent reporting, for the Terminal Control Unit.

FUNCTION

The functions of the Radar Data Processing System (RDPS) include centralized processing for surveillance data received from enroute, terminal, and Mode S sensors, automatic tracking, data entry and display, and diagnostics and repair.

The Radar Data Processing System (RDPS) will handle all surveillance data processing including dependent and independent reporting.

3.1.2.4 Interfacility Communications System (ICS)

PURPOSE

All interfacility communications will be handled by the national network and switching system.

FUNCTION

3.1.2.5 Common Controller Workstations (CCWS)

PURPOSE

The Common Controller Workstation (CCWS) will be an integrated and versatile sector suite with the capability of being operated by one controller and will consist of an operating position and a workstation processor. The operating position will be a modular, ergonomically designed control and display position with tactile input devices, high resolution display devices, and auditory output and input systems. The work station processor will interface to the network and will be operator configurable to meet the particular position requirements.

FUNCTION

The principal functions of the Common Controller Workstation (CCWS) are to provide electronic displays of digital radar data, flight plan data, weather data, and supplementary aeronatuical information and provide for raw data processing in the event of loss of computed data from a central processing function.

3.1.3 CONTROL TOWER

PURPOSE

The Control Tower provides for the control of aircraft arriving or departing an airport, operating within a defined control zone, and all aircraft and vehicular traffic operating on the manoevering surface of an airport.

FUNCTION

The following descriptions are the major functions of a Control Tower.

Flight Data Processing in Control Towers is a function limited to accepting flight plan data information from Terminal Control Units or Area Control Centers and performing processing that is required only for internal transfer. The capability to manually enter flight plans or acquire them from a bulk storage file in the event of a communications failure with the Terminal Control Unit or Area Control Center will also be provided.

Data Display Processing is the acquisition of data to be displayed from the surveillance data, flight data, weather data, and aeronautical information processing systems. Based on air traffic controller inputs and settings (via interactive input devices), the data will be presented on the appropriate output device(s), such as CRT terminals and printers, at the Common Controller Workstation.

Weather Data Processing within the Control Tower is the collection and processing of current and forecasted weather conditions so as to enable accurate time/distance calculations pertaining to the planned and actual flight of all aircraft through the Tower Control Zone. In addition, selected weather products will be provided to all users.

Operational Reconfiguration is the functional capability to automatically reconfigure all processing and display functions when the Control Tower is operationally reconfigured for special situations or other operational requirements.

Surveillance Data Processing is the correllation of air traffic position coordinates and identity codes to flight plan data to produce a "best" track for each aircraft which is maintained (while in the jurisdiction area) and formatted for transfer to the Data Display System.

Mode S data link messages are also received and preprocessed for transfer to the appropriate colocated equipment or other facility.

Conflict prediction, resolution advisory, and minimum safe altitude warning tasks will be performed within the Surveillance Data Processing function.

Common Time Distribution is the acquisition and distribution of a common reference time source to ensure the synchronization of all independent systems.

Communications Switching is a communications bank that handles all voice and data inputs and outputs and is capable of providing full flexibility in communications reconfigurations.

Aeronautical Information Processing provides a national and selected international storage of current aeronautical information such as airport approach procedures, airways, restricted areas, Notices to Airmen (NOTAMS), airport conditions, and equipment operational status'. This information will be disseminated to all air traffic service and user access terminals.

Recording is the function of providing and storing all information that enables the reproduction of the total air traffic situation as it occurred in any point in time. This reproduction capability will be made available at the site, Regional Air Traffic Simulation Facility, as well as at national facilities (RESC, TSC, TCTI). This information will include the dynamic air traffic situation, communications, all displays, weather, and aeronautical information.

Operational Statistics Analysis and Accumulation will provide Transport Canada with all necessary statistics for cost recovery from users as well as monitoring sector and workstation workloads, system utilization, and airspace utilization for efficient system management.

CONTROL TOWER

FUNCTIONAL INPUTS

FROM	LOC	NAME	STANDARD	LOC
ACC		Flt Pln	ICAO4444	
ASDE		ASDE Msg		
CAT1ILS		RVR		
CAT2ILS		RVR		
CAT3ILS		RVR		
ACC		Now Wx		
AWORS		Now Wx		
ACC		Fcst Wx		
ACC		SIGMETS		
ACC		Flow Mgmt		
SINGLCOM		Wx Request		
MULTICOM		Wx Request		
SINGLCOM		AIP Req		
MULTICOM		AIP Req		
ACC		AID Base		
ACC		NOTAMS		
RMTCECTR		Equip Stat		
ACC		ATC Comm		
TCU		ATC Comm		
NONTCFAC		ATC Comm		
ACC		Handoff DA		
TCU		Handoff DA		
NONTCFAC		Handoff DA		
TSR		Psn Rpt RA		
SINGLCOM		ATCComm AG		
MULTICOM		ATCComm AG		
SINGLCOM		PIREPS		
SINGLCOM		Distrs Msg		
MULTICOM		Distrs Msg		
ACC		Time Sync		
VHF/DF		VHF/DF		
TSR		Wx Radar		
WNDSHEAR		Wind Shear		
WAKEVRTX		Wake Vortx		
AIRCRAFT		Aprt Stat		
AIRCRAFT		Gate Asnmt		

FACILITY PRINCIPAL FUNCTIONS

REQUIREMENT	DESCRIPTION	SPECIFICATION
	Surveillance Data Processing	
	Flight Data Processing	
	Display Processing	
	Weather Data Processing and Distribution	
	Common Time Distribution	
	Communication Switching	
	Aeronautical Information Processing	
	Recording	
	Operational Statistics Analysis (Off-Line) and Accumulation	
	Operational Reconfigurations	
	NOTE: At some Towers Radar Data Processing will not exist.	

FUNCTIONAL OUTPUTS

LOC	NAME	STANDARD	TO	LOC
	Flt Pln	ICAO4444	ACC	
	SIGMETS		ACC	
	Flow Mgmt		ACC	
	Aero Info		ACC	
	NOTAMS		ACC	
	Equip Stat		RMTCECTR	
	ATC Comm		ACC	
	ATC Comm		TCU	
	ATC Comm		NONTCFAC	
	Handoff DA		ACC	
	Handoff DA		TCU	
	Handoff DA		NONTCFAC	
	D/Link Msg		TSR	
	ATCComm AG		SINGLCOM	
	ATCComm AG		MULTICOM	
	PIREPS		AVWXCTR	
	PushToTalk		SINGLCOM	
	PushToTalk		MULTICOM	
	Statistics		ACC	
	SAR VC		ACC	
	ATIS		SINGLCOM	
	ASDE Adj		ASDE	
	DF Ctl		VHF/DF	
	Light Ctl			
	Rnwy Light			

EQUIPMENT TYPES

- o Radar Data Processing System
- o Interfacility Communications System
- o Common Controller Work Stations
- o Communications Control System
- o
- o
- o

FIGURE 3-5

CANADIAN AIRSPACE SYSTEM
SYSTEM DESIGN
LEVEL ONE

SEPTEMBER 1985

3.1.3.1 Radar Data Processing System (RDPS)

PURPOSE

The Radar Data Processing System (RDPS) provides for all surveillance data processing, including dependent and independent reporting, for the Control Tower.

FUNCTION

The functions of the Surveillance Data Processing System (SDPS) include centralized processing for surveillance data received from enroute, terminal, and Mode S sensors, automatic tracking, data entry and display, and diagnostics and repair.

3.1.3.2 Communications Control System

Communications control will be handled by a common network and controller for the facility.

PURPOSE

The Communications Control System (CCS) provides the intrafacility voice links as well as the interfacility and ground-air communications interface.

FUNCTION

The functions of the Communications Control System (CCS) includes direct switching, trunking, configuration and reconfiguration, internal diagnostics, redundancy, and transaction recording.

3.1.3.3 Interfacility Communications System

PURPOSE

All interfacility communications will be handled by the national network and switching system.

FUNCTION

3.1.3.4 Common Controller Work Stations

PURPOSE

The Common Controller Workstation (CCWS) will be an integrated and versatile sector suite with the capability of being operated by one controller and will consist of an operating position and a workstation processor. The operating position will be a modular, ergonomically designed control and display position with tactile input devices, high resolution display devices, and auditory output and input systems. The work station processor will interface to the network and will be operator configurable to meet the particular position requirements.

FUNCTION

The principal functions of the Common Controller Workstation (CCWS) are to provide electronic displays of digital radar data, flight plan data, weather data, and supplementary aeronatuical information and provide for raw data processing in the event of loss of computed data from a central processing function.

3.2 ADVISORY FACILITIES

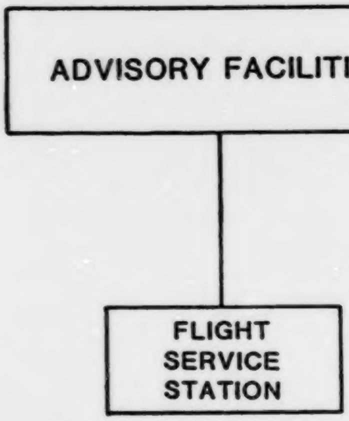


FIGURE 3-6

DESCRIPTION

This section describes the advisory facilities of the Canadian Airspace System. It is comprised of those Flight Service Stations that provide local and regional flight planning and flight following services primarily for domestic users of the Canadian Airspace System and, in certain geographic areas, the provision of advisory services to international users. Additionally, these facilities provide weather observing and reporting as well as advisory services for remote airports.

3.2.1 FLIGHT SERVICE STATION

PURPOSE

The Flight Service Station (FSS) is a strategically located facility that provides information and advice to pilots in all phases of flight. In addition, the Flight Service Station specialist provides support functions for the weather data acquisition program of the Atmospheric Environment Service (AES) and aviation statistics for Transport Canada planning purposes.

FUNCTION

The following describes the levels of services and functions provided by the Flight Service Station.

Level 1: This service may be described as the provision of minimum operational information a pilot requires before commencing an instrument approach to an airport. Where a Remote Communications Outlet (RCO) is used as the air-ground communications facility, Flight Service Station (FSS) personnel will provide the service. Where an RCO is not involved, authorized persons such as air carrier company or weather station personnel, will provide the service. Future weather sensors with a voice synthesized broadcast capability will fulfill the Level 1 requirement.

The operational information consists, at minimum, of current weather with wind direction and speed and current altimeter setting. However, other information of concern to the flight crew will also be included.

Level 2: The Remote Flight Service Station (RFSS) is an unmanned FSS facility located on an airport, with a surface weather reporting station on site, and meeting the criteria established for Level 2 service. The facility consists of an air-ground airport advisory frequency designated the Mandatory Frequency (MF), and a remote vehicle advisory frequency used to coordinate the movement of vehicles on the airport manoevering area to avoid vehicle conflict with arriving and departing aircraft. A third frequency will be provided at locations meeting the requirement for enroute communications. Remote operation from the staffed FSS will thus permit the service range of that facility to be extended to the associate airport and surrounding area.

The services provided by the RFSS consist of the following:

(a) Remote Airport Advisory Service (RAAS) over a frequency designated as the Mandatory Frequency.

(b) Remote vehicle advisory service.

(c) Flight plan service by toll free telephone.

(d) Aviation Weather Information Service (AWIS) by toll free telephone.

(e) VFR alerting service.

(f) Aeronautical broadcast service as required.

(g) Navigation assistance service including VHF/DF as required.

(h) Navigation aids service.

(i) Notice To Airmen (NOTAM) service.

(j) Pilot Report (PIREPS).

(k) Enroute communications service as required.

Level 3: This service is the manned FSS. The manned FSS is an Air Traffic Services facility staffed by flight service specialists located on an aerodrome; the service is responsible for pre-flight and in-flight pilot briefing, enroute communications for all VFR and some IFR flight, assisting lost aircraft, originating NOTAMs, broadcasting flight information, accepting and closing flight plans, monitoring radio aids for navigation, alerting search and rescue operations, and operating nationals and international teletypewriter network systems. In addition, at many locations, the FSS performs all aviation weather functions, provides airport advisory service, manages vehicle movements on airports, provides a direction finding service, and advises Customs of transborder flights.

The typical manned FSS is located on an airport, operates 24 hours per day, and employs six or seven flight service specialists. The airport advisory frequency is the designated Mandatory Frequency (MF), and positive vehicle advisory service is provided over a dedicated vehicle frequency. In recent years, a number of staffed stations have become multi-position facilities controlling at least one RFSS facility or RCO, or both. These multi-position facilities will develop rapidly when Automated Weather Observing and Reporting Systems (AWORS) come into common use.

A summary of the basic functions of the FSS and the corresponding processes follows:

Flight Plan Handling. The FSS can open or close a flight plan. Flight plan data is acquired and disseminated via the communications control equipment and the telecommunications network. Input is also via face-to-face over the counter dialogue between the pilot and the FSS specialist.

Weather Data Input and Output. The FSS selects, stores, and distributes weather products (in both alpha-numeric and graphic formats). The Area Control Centre (ACC) Weather Processor is the source of aviation weather data. The local weather data base is updated in real-time.

Communications Control. This system processes all air-ground and point-to-point voice and data communications entering or leaving the FSS. The switched telecommunications network is included.

Display System. This system provides for local storage and display processing of weather data (including graphics), aeronautical information (including graphics), and facility status information.

Aviation Statistics. Aviation statistics are developed and maintained in a local data base containing station statistics. This data is then fed to the national aeronautical information system via the switched telecommunications network.

FLIGHT SERVICE STATION

FUNCTIONAL INPUTS

FROM	LOC	NAME	STANDARD	LOC
HFCOM		ATCComm DA		
SATCOM		ATCComm DA		
SINGLCOM		ATCComm VC		
MULTICOM		ATCComm VC		
HFCOM		ATCComm VC		
SATCOM		ATCComm VC		
ACC		Wx Data		
AVWXCTR		Wx Data		
AWORS		Wx Data		
ACC		Flt Plan		
FSS		VFRAlertVC		
FSS		VFRAlertVC		
LANDLINE		VFRAlertVC		
VORDMTAC		NavMntr DA		
NDB		NavMntr DA		
VHF/DF		VHF/DF DA		
AIRLINES		PaidCommDA		
AIRLINES		PaidCommVC		
AMTCECTR		Mntnc Req		
AMTCECTR		Mntnc Ctl		
ACC		NOTAMS		
AIRLINES		ATCComm DA		
ACC		ATCComm DA		
HFCOM		ATCComm DA		
HFCOM		ATCComm VC		
NONTCFAC		IntlCommDA		
HFCOM		IntlCommVC		
AIRLINES		PaidCommVC		
HFCOM		PaidCommVC		
AIRLINES		PaidCommDA		
HFCOM		PaidCommDA		

FACILITY PRINCIPAL FUNCTIONS

REQUIREMENT	DESCRIPTION	SPECIFICATION
	Provide enroute flight, airport, and positive vehicle advisories by VHF/UHF/HF radio	
	Flight planning service by VHF/UHF radio, telephone, and personal (file, amend, cancel)	
	VFR alerting	
	Aviation weather by radio, telephone, and personal	
	Navigational assistance	
	NAVAID monitoring	
	NOTAMs and PIREPs	
	Paid communications	
	Surface weather observations	
	Record all voice transmissions	
	Fixed communications	
	Maintenance remotely controlled	

FUNCTIONAL OUTPUTS

LOC	NAME	STANDARD	TO	LOC
	ATCComm DA		HFCOM	
	ATCComm DA		SATCOM	
	ATCComm VC		SINGLCOM	
	ATCComm VC		MULTICOM	
	ATCComm VC		HFCOM	
	ATCComm VC		SATCOM	
	Weather DA		ACC	
	Weather DA		AES	
	Weather VC		CADINCTL	
	Flt Plan		AIRLINES	
	Flt Plan		ACC	
	VFRAlertDA		ACC	
	VFRAlertDA		FSS	
	VFRAlertVC		FSS	
	PaidCommDA		AIRLINES	
	PaidCommVC		AIRLINES	
	SELCAL		SINGLCOM	
	Mntnc Data		AMTCECTR	
	NOTAMS		FSS	

EQUIPMENT TYPES

- Communications Control Equipment
- Video Display Terminals
- Weather Displays
- VHF/DF
- Recorders
- Display Processors
-
-
-
-

FIGURE 3-7

CANADIAN AIRSPACE SYSTEM
SYSTEM DESIGN
LEVEL ONE

SEPTEMBER 1985

The Flight Service Station, like the Area Control Centre, Terminal Control Unit, and Control Tower, is based on a workstation concept. All equipment (functions) must be integrated into a common ergonomically designed workstation. The principal equipment elements are described in this section.

3.2.1.1 Communications Control Equipment.

3.2.1.2 Video Display Terminals.

3.2.1.3 Weather Displays.

3.2.1.4 Very High Frequency/Direction Finder (VHF/DF).

3.2.1.5 Recorders.

3.2.1.6 Display Processors.

3.3 NATIONAL FACILITIES

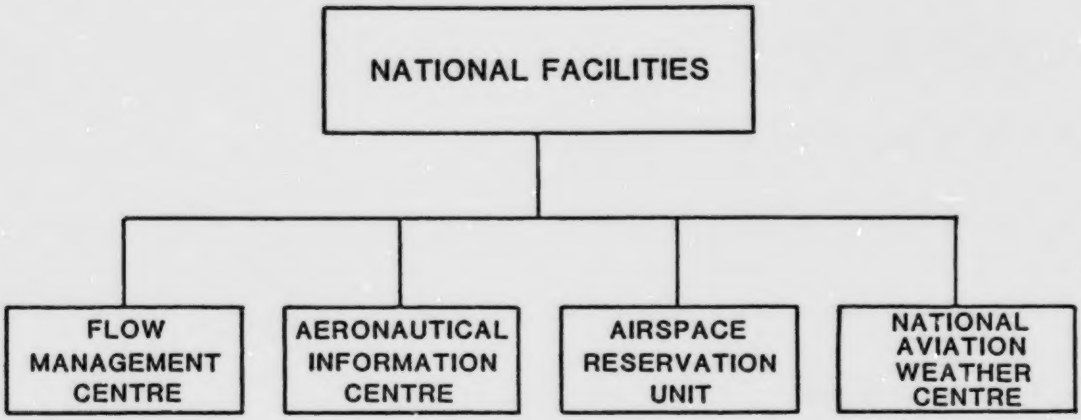

NATIONAL FACILITIES
FLOW MANAGEMENT CENTRE
AERONAUTICAL INFORMATION CENTRE
AIRSPACE RESERVATION UNIT
NATIONAL AVIATION WEATHER CENTRE

FIGURE 3-8

DESCRIPTION

National Facilities consist of those functions that require large data bases of information and a single overall view of the national situation. They provide flow management support and services at the national level through centralized collection, processing, and dissemination facilities. The National Facilities consist of the Flow Management Centre, Aeronautical Information Centre, Airspace Reservation Unit, and the National Aviation Weather Centre.

3.3.1 FLOW MANAGEMENT CENTRE

PURPOSE

The Flow Management Centre provides a centralized overview of the national traffic situation as it exists and as it is planned and projected. It allows flow management personnel to evaluate the impact of various traffic management alternatives and permits strategic planning to adjust traffic flows in the most efficient manner possible.

FUNCTION

Utilizing inputs from the Aeronautical Information Centre, Airspace Reservation Unit, National Aviation Weather Centre, airline operations offices, and other flight planning facilities, the Flow Management Centre's function is to process flight planning information in relation to existing existing traffic activities in a dynamic system model to provide:

- Conflict free and fuel efficient flight profiles.
- Automatic conflict resolution alternatives.
- Automatic dissemination of information between the Flight Data Processing System, Area Control Centres, and Flight Planning facilities.

FLOW MANAGEMENT CENTRE

FUNCTIONAL INPUTS				
FROM	LOC	NAME	STANDARD	LOC

FACILITY PRINCIPAL FUNCTIONS		
REQUIREMENT	DESCRIPTION	SPECIFICATION

FUNCTIONAL OUTPUTS				
LOC	NAME	STANDARD	TO	LOC

EQUIPMENT TYPES	
o	o
o	o
o	o
o	o
o	o
o	o

FIGURE 3-9

3.3.1.1 - 3.3.1.X (Flow Management Centre Equipment Descriptions to be supplied during next phase)

3.3.2 AERONAUTICAL INFORMATION CENTRE

PURPOSE

The Aeronautical Information Centre provides a centralized facility for the collection, processing, and dissemination of accurate and timely aeronautical information that is essential to ensure safe and efficient air traffic control.

FUNCTION

The function of the Aeronautical Information Centre is to automatically process and transfer aeronautical data between all air traffic control and user facilities to ensure that reasonable requirements and demands on the Canadian Airspace System are routinely satisfied in a cost efficient manner.

AERONAUTICAL INFORMATION CENTRE

FUNCTIONAL INPUTS				
FROM	LOC	NAME	STANDARD	LOC

FACILITY PRINCIPAL FUNCTIONS		
REQUIREMENT	DESCRIPTION	SPECIFICATION

FUNCTIONAL OUTPUTS				
LOC	NAME	STANDARD	TO	LOC

EQUIPMENT TYPES	
○	○
○	○
○	○
○	○
○	○
○	○

FIGURE 3-10

3.3.2.1 - 3.3.2.X (Aeronautical Information Centre Equipment Descriptions to be supplied during next phase)

3.3.3 AIRSPACE RESERVATION UNIT

PURPOSE

To provide a centralized airspace reservation facility to aid in providing more efficient flight planning and fuel efficient route assignments during special flight operations.

FUNCTION

Utilizing inputs from the Flow Management Centre, Aeronautical Information Centre, National Aviation Weather Centre, Department of National Defense, airline operations offices, and other flight planning facilities the Airspace Reservation Unit's function is to process flight planning airspace requests, for special flight operations, in relation to existing and planned traffic activities and provide designated airspace reservations to the Flow Management Centre and users.

AIRSPACE RESERVATION UNIT

FUNCTIONAL INPUTS				
FROM	LOC	NAME	STANDARD	LOC

FACILITY PRINCIPAL FUNCTIONS		
REQUIREMENT	DESCRIPTION	SPECIFICATION

FUNCTIONAL OUTPUTS				
LOC	NAME	STANDARD	TO	LOC

EQUIPMENT TYPES	
o	o
o	o
o	o
o	o
o	o
o	o

FIGURE 3-11

CANADIAN AIRSPACE SYSTEM
SYSTEM DESIGN
LEVEL ONE

SEPTEMBER 1985

3.3.3.1 - 3.3.3.X (Airspace Reservation Unit Equipment Descriptions to be supplied during next phase)

3.3.4 NATIONAL AVIATION WEATHER CENTRE

PURPOSE

The National Aviation Weather Centre acquires current and forecasted weather information and maintains a central aviation weather data base that is accessible by all facilities in the Canadian Airspace System. The National Aviation Weather Centre will also act as a gateway to other national or international weather data bases to facilitate acquisition of weather products not normally maintained "in-house".

FUNCTION

The following are functions of the National Aviation Weather Centre:

- Supports an interactive data link with the United States' Federal Aviation Administration and National Weather Service for the purposes of receiving and transmitting alpha-numeric and graphic weather data.
- Processes raw weather data from the Automated Weather Observation and Reporting System (AWORS) and produces consolidated bulletins and graphics products for redistribution to Area Control Centres, Terminal Control Units, Control Towers, Flight Service Stations, Direct User Access Terminals, and the Atmospheric Environment Service (AES).
- Receives other weather data such as AES now weather and forecasts, Pilot Reports (PIREPS), Significant Meteorological Information (SIGMETS), and Weather Radar, Facsimile, and Satellite data from Area Control Centres, Flight Service Stations, Control Towers, and the Department of National Defense for processing and redistribution.
- Compiles appropriate aviation weather statistics.
- Generates appropriate status and alarm indications for the Control and Performance Monitoring System (CPMS).
- Formats selected weather products for use in the Voice Response System (VRS).

NATIONAL AVIATION WEATHER CENTRE

FUNCTIONAL INPUTS				
FROM	LOC	NAME	STANDARD	LOC
AES		Fcst Wx		
AES		Wx Sat		
WXRADAR		Wx Radar		
AES		Now Wx		
ACC		Now Wx		
ACC		SIGMETS		
RMTCECTR		Mntnc Req		
RMTCECTR		Mntnc Ctl		

FACILITY PRINCIPAL FUNCTIONS		
REQUIREMENT	DESCRIPTION	SPECIFICATION
	Receive forecasted weather from AES and passes to regional weather processors (in ACC.s) and DUATS	
	Receive Now Weather AWORS from regional processors	
	Interactive data link with the United States (NWS and FAA)	
	Receive and processes facsimile data, radar data, and satellite data	
	Maintenance remotely controlled	

FUNCTIONAL OUTPUTS				
LOC	NAME	STANDARD	TO	LOC
	Fcst Wx DA		ACC	
	Wx Sat		ACC	
	Now Wx DA		ACC	
	Wx Radar		ACC	
	SIGMET		ACC	
	Mntnc Data		RMTCECTR	

EQUIPMENT TYPES	
o	o
o	o
o	o
o	o
o	o
o	o

FIGURE 3-12

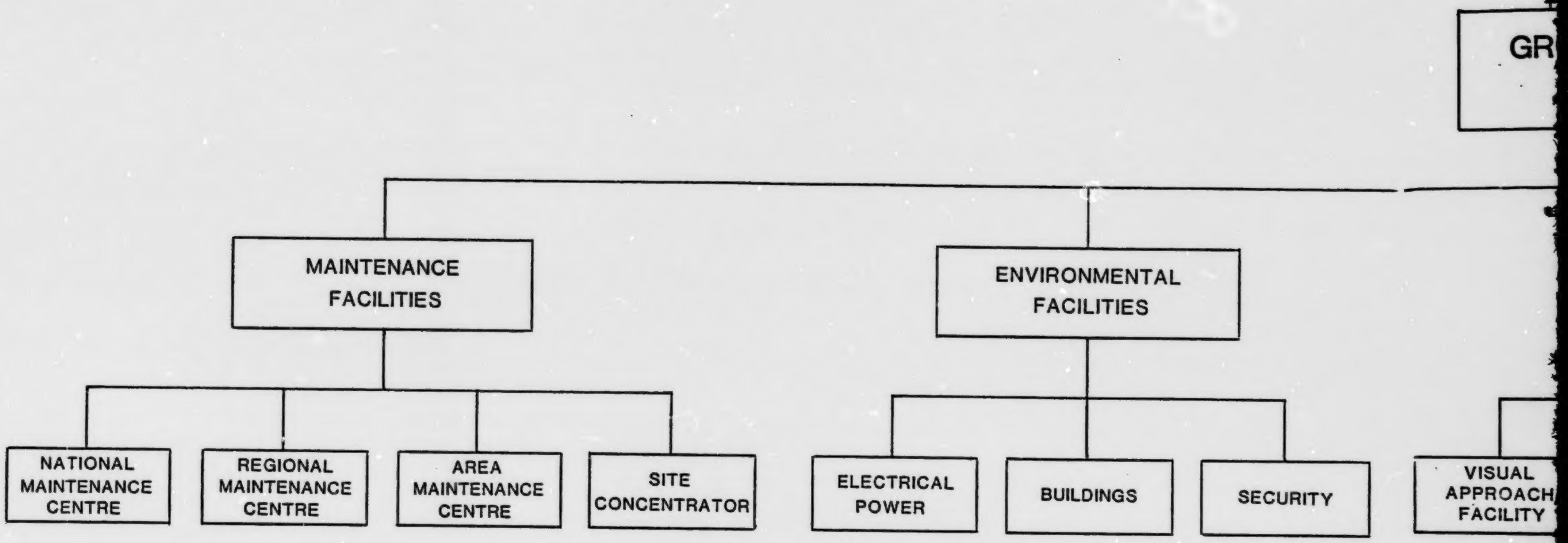
3.3.4.1 - 3.3.4.X (National Aviation Weather Centre Equipment
Descriptions to be supplied during next phase)

CANADIAN AIRSPACE SYSTEM

GROUND-TO-AIR ELEMENT

4.0 GROUND-TO-AIR ELEMENT

This chapter describes the Ground-To-Air Element which is comprised of those surveillance, communications, navigation, and weather sensing facilities and associated equipment that provide support to air traffic control and flight service operations as well as to other users of the Canadian Airspace System.


GR
MAINTENANCE FACILITIES
ENVIRONMENTAL FACILITIES
NATIONAL MAINTENANCE CENTRE
REGIONAL MAINTENANCE CENTRE
AREA MAINTENANCE CENTRE
SITE CONCENTRATOR
ELECTRICAL POWER
BUILDINGS
SECURITY
VISUAL APPROACH FACILITY

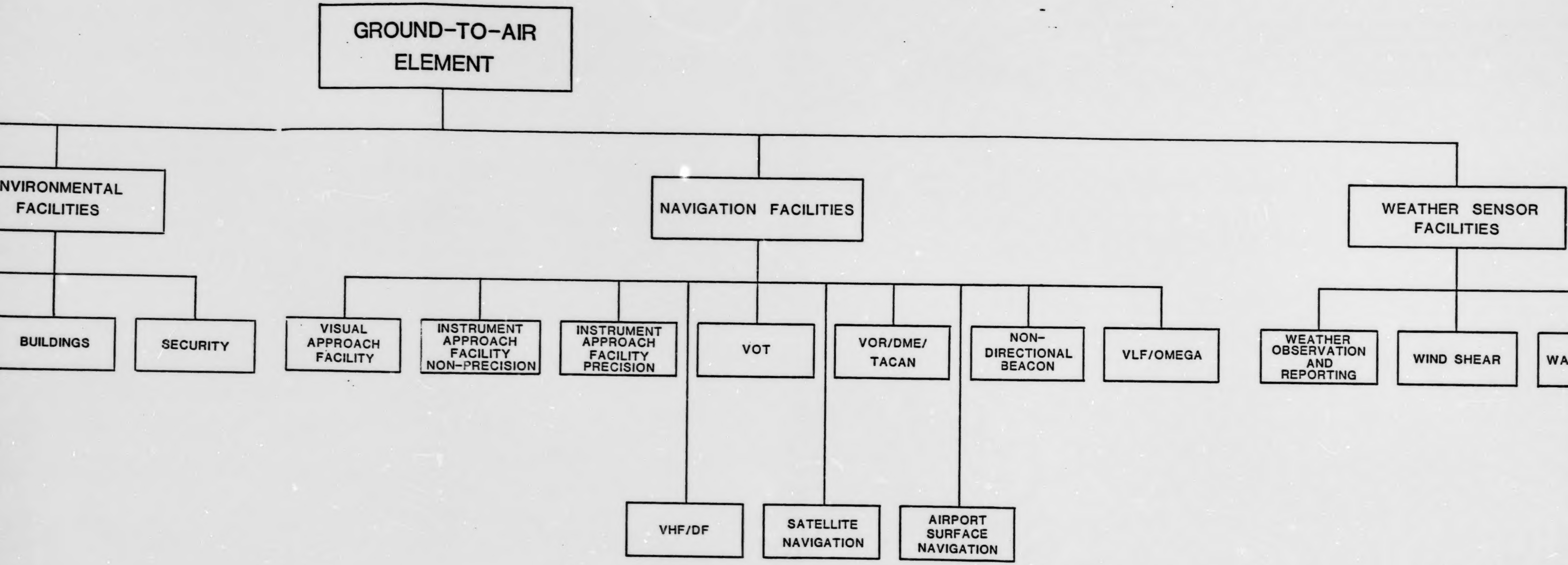
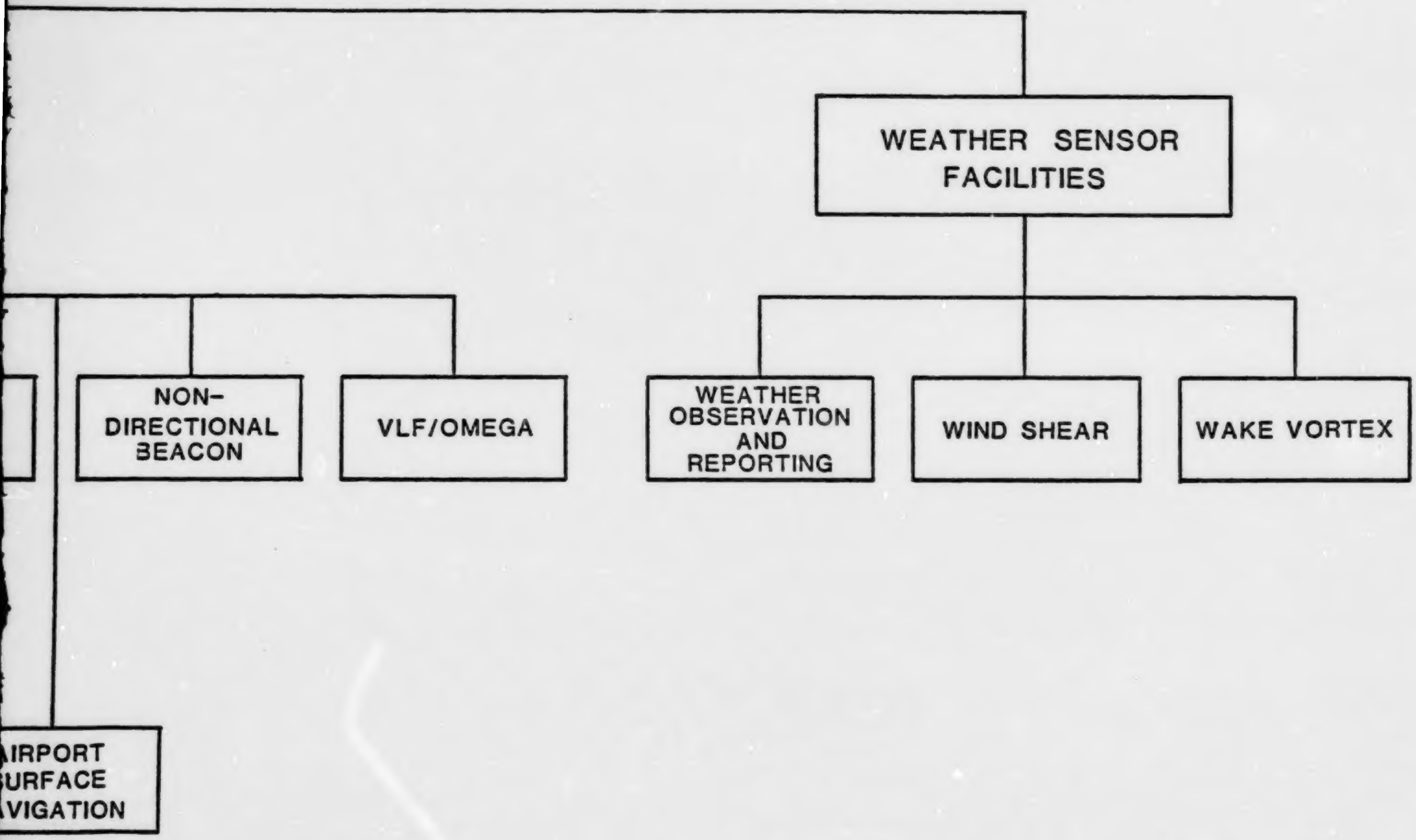

GROUND-TO-AIR ELEMENT
NVIRONMENTAL FACILITIES
NAVIGATION FACILITIES
WEATHER SENSOR FACILITIES
BUILDINGS
SECURITY
VISUAL APPROACH FACILITY
INSTRUMENT APPROACH FACILITY NON-PRECISION
INSTRUMENT APPROACH FACILITY PRECISION
VOT
VOR/DME/ TACAN
NON-DIRECTIONAL BEACON
VLF/OMEGA
WEATHER OBSERVATION AND REPORTING
WIND SHEAR
WA
VHF/DF
SATELLITE NAVIGATION
AIRPORT SURFACE NAVIGATION

FIGURE 4-1


WEATHER SENSOR FACILITIES
NON-DIRECTIONAL BEACON
VLF/OMEGA
WEATHER OBSERVATION AND REPORTING
WIND SHEAR
WAKE VORTEX
IRPORT URFACE VIGATION

4.1 SURVEILLANCE FACILITIES

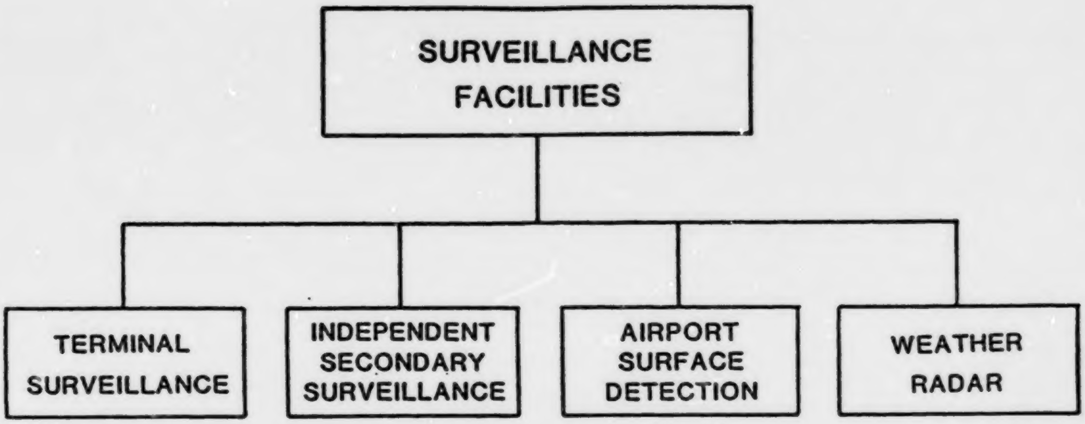

SURVEILLANCE FACILITIES
TERMINAL SURVEILLANCE
INDEPENDENT SECONDARY SURVEILLANCE
AIRPORT SURFACE DETECTION
WEATHER RADAR

FIGURE 4-2

DESCRIPTION

The surveillance facilities are comprised of the Terminal Surveillance, Independent Secondary Surveillance, Airport Surface Detection, and Weather Radar facilities. Their basic functions are to provide search radar surveillance, beacon surveillance, data link as a supplement to ground-to-air communications, and weather radar surveillance.

The Terminal Surveillance facility provides surveillance coverage for terminal airspace and also completes enroute surveillance coverage requirements. The Independent Secondary Surveillance facility provides long range radar surveillance coverage for the enroute structure. The Airport Surface Detection facility is a stand-alone system which provides detection of aircraft and vehicles on the manoevering surface of an airport, especially during low visibility conditions. The Weather Radar facility provides weather radar information to the National Aviation Weather Centre.

4.1.1 TERMINAL SURVEILLANCE

PURPOSE

Terminal Surveillance provides for the acquisition of position and identity information for all aircraft within the coverage provided by the site. Nominal coverages are: 80 nautical miles at 23,000 feet above ground level for Primary Surveillance Radar and 250 nautical miles at 70,000 feet above ground level for Secondary Surveillance Radar.

In addition, a weather contour detection capability will be provided.

FUNCTION

The primary function of the Terminal Surveillance facility is to detect and identify the presence and location of airborne targets within the Terminal Control Area (TCA) or Control Zone (CZ). As well, it will monitor various maintenance and performance parameters and respond to maintenance control commands and requests in support of the Control and Performance Monitoring System (CPMS).

TERMINAL SURVEILLANCE

FUNCTIONAL INPUTS				
FROM	LOC	NAME	STANDARD	LOC
A/C		Xpnd Reply		
A/C		D/L Reply		
RMTCECTR		Equip Ctl		
ACC		D/L Msg		
TCU		D/L Msg		

FACILITY PRINCIPAL FUNCTIONS		
REQUIREMENT	DESCRIPTION	SPECIFICATION
	Primary Surveillance Radar:	
	Transmission/Modulation	
	Reception/Demodulation	
	Return Processing (Digitizing, Tracking)	
	Weather Channel Processing	
	Secondary Surveillance Radar:	
	Interrogation/ Modulation	
	Reception/Demodulation	
	Return Processing (Digitizing, Tracking)	
	General:	
	Performance and Status Monitoring	
	PSR/SSR Correlation	
	Message Formatting (for output)	

FUNCTIONAL OUTPUTS				
LOC	NAME	STANDARD	TO	LOC
	Xmit Pulse		A/C	
	Interrog		A/C	
	D/L Msg		A/C	
	PriTgtRply		ACC	
	PriTgtRply		TCU	
	SSRTgtRply		ACC	
	SSRTgtRply		TCU	
	SSRTgtRply		DUAT	
	SSRTgtRply		NONTCFAC	
	Wx Message		ACC	
	Wx Message		TCU	
	Wx Message		TWR	
	Equip Stat		RMTCECTL	
	ModeS Rply		ACC	
	ModeS Rply		TCU	
	ModeS Rply		TWR	

EQUIPMENT TYPES	
o	o
o	o
o	o
o	o
o	o
o	o

FIGURE 4-3

CANADIAN AIRSPACE SYSTEM
SYSTEM DESIGN
LEVEL ONE

SEPTEMBER 1985

4.1.1.1 - 4.1.1.X (Terminal Surveillance Equipment Descriptions to be supplied during next phase)

4.1.2 INDEPENDENT SECONDARY SURVEILLANCE

PURPOSE

Independent Secondary Surveillance provides for the acquisition of position and identity information for all aircraft within the coverage provided by the site. The nominal coverage is: 250 nautical miles at 70,000 feet above ground level for Secondary Surveillance Radar.

FUNCTION

The primary function of the Independent Secondary Surveillance facility is to detect and identify the presence and location of airborne targets within a Flight Information Region (FIR). As well, it will monitor various maintenance and performance parameters and respond to maintenance control commands and request in support of the Control and Performance Monitoring System (CPMS).

INDEPENDENT SECONDARY SURVEILLANCE

FUNCTIONAL INPUTS				
FROM	LOC	NAME	STANDARD	LOC

FACILITY PRINCIPAL FUNCTIONS		
REQUIREMENT	DESCRIPTION	SPECIFICATION

FUNCTIONAL OUTPUTS				
LOC	NAME	STANDARD	TO	LOC

EQUIPMENT TYPES	
○	○
○	○
○	○
○	○
○	○
○	○

FIGURE 4-4

CANADIAN AIRSPACE SYSTEM
SYSTEM DESIGN
LEVEL ONE

SEPTEMBER 1985

4.1.2.1 - 4.1.2.X (Independent Secondary Surveillance Equipment Descriptions to be supplied during next phase)

4.1.3 AIRPORT SURFACE DETECTION

PURPOSE

The Airport Surface Detection facility provides the capability to detect and display all vehicular traffic on the manoevering surface of the airport.

FUNCTION

The Airport Surface Detection facility will provide for a means for surface control, such as taxiing instructions, clearances to push back, and clearances to cross active airport areas, at busy airports, particularly during periods of reduced visibility.

A supporting function will be to monitor various maintenance and performance parameters and respond to maintenance control commands and requests in support of the Control and Performance Monitoring System (CPMS).

AIRPORT SURFACE DETECTION

FUNCTIONAL INPUTS				
FROM	LOC	NAME	STANDARD	LOC
RMTCECTR		Equip Ctl		
TWR		Ops Ctl		

FACILITY PRINCIPAL FUNCTIONS		
REQUIREMENT	DESCRIPTION	SPECIFICATION
Real-Time, High Res Display of Surface Tfc Within an Arpt Area	Transmission/Modulation Reception/Demodulation Message Formatting (for output) Performance and Status Monitoring	

FUNCTIONAL OUTPUTS				
LOC	NAME	STANDARD	TO	LOC
	Xmit Pulse			
	ASDE Msg		TWR	
	Equip Stat		RMTCECTR	

EQUIPMENT TYPES	
○	○
○	○
○	○
○	○
○	○
○	○

FIGURE 4-5

4.1.3.1 - 4.1.3.X (Airport Surface Detection Equipment Descriptions to be supplied during next phase)

4.1.4 WEATHER RADAR

PURPOSE

The Weather Radar facility provides for the detection of atmospheric phenomena, in particular precipitation, in defined geographic areas, on a real-time basis, and provides that information to the Regional Aviation Weather Processor.

FUNCTION

The Weather Radar will provide air traffic control and flight service facilities with adequate information in order to inform pilots of weather conditions along their intended flight paths as well as providing meteorological information for flight planning and flow control functions.

WEATHER RADAR

FUNCTIONAL INPUTS				
FROM	LOC	NAME	STANDARD	LOC
		Wx Return		
RMTCECTR		Equip Ctl		
ACC		Equip Ctl		
TCU		Equip Ctl		
TWR		Equip Ctl		
FSS		Equip Ctl		

FACILITY PRINCIPAL FUNCTIONS		
REQUIREMENT	DESCRIPTION	SPECIFICATION
	Transmission/Modulation	
	Reception/Demodulation	
	Processing (Quantizing)	
	Message Formatting (for output)	
	Performance and Status Monitoring	

FUNCTIONAL OUTPUTS				
LOC	NAME	STANDARD	TO	LOC
	Xmit Pulse			
	Wx Msg RA		ACC	
	Wx Msg RA		TCU	
	Wx Msg RA		TWR	
	Wx Msg RA		AVWXCTR	
	Equip Stat		RMTCECTR	

EQUIPMENT TYPES	
o	o
o	o
o	o
o	o
o	o
o	o

FIGURE 4-6

4.1.4.1 - 4.1.4.X (Weather Radar Equipment Descriptions to be supplied during next phase)

4.2 COMMUNICATIONS FACILITIES

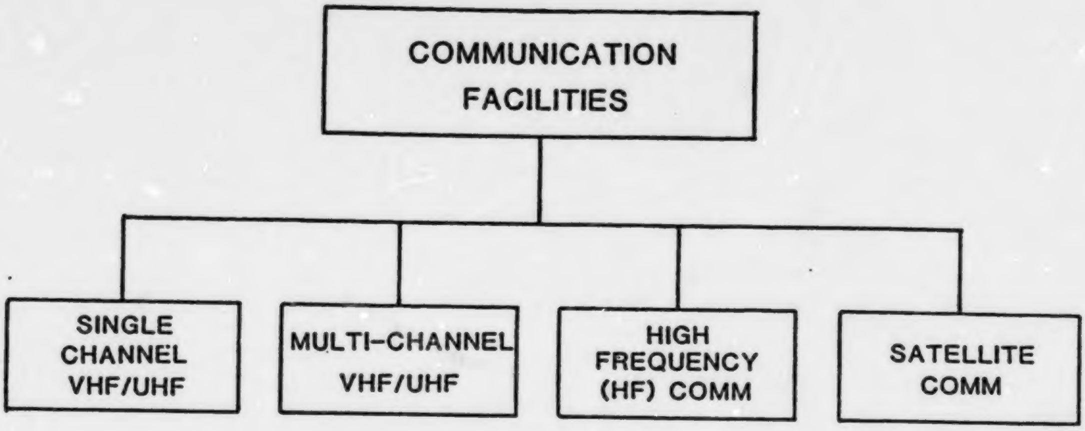

COMMUNICATION FACILITIES
SINGLE CHANNEL VHF/UHF
MULTI-CHANNEL VHF/UHF
HIGH FREQUENCY (HF) COMM
SATELLITE COMM

FIGURE 4-7

DESCRIPTION

Ground-to-air communications facilities provide voice radio communications between controllers, flight service specialists and pilots in both enroute and terminal airspace.

Communications Facilities are comprised of the Single Channel VHF/UHF, Multi-Channel VHF/UHF, High Frequency (HF) Communications, and Satellite Communications facilities.

4.2.1 SINGLE CHANNEL VHF/UHF

PURPOSE

The Single Channel VHF/UHF facility is a remotely located facility which provides extended air/ground communications for the Area Control Centre and Flight Service Station.

FUNCTION

The following are functions of the Single Channel VHF/UHF facility:

- Processes, transmits, and receives VHF/UHF voice communications between aircraft under Visual Flight Rules (VFR) and Instrument Flight Rules (IFR), Area Control Centres, and Flight Service Stations within a specified region.
- Processes alarm functions for transmittal to an Area Maintenance Centre.
- Processes operational control functions.
- Transmits maintenance data to an Area Maintenance Centre for equipment certification and trend analysis.

SINGLE CHANNEL VHF/UHF

FUNCTIONAL INPUTS				
FROM	LOC	NAME	STANDARD	LOC
ACC		ATC Comm		
FSS		ATC Comm		
FSS		SELCAL		
AIRCRAFT		PushToTalk		
RMTCECTR		Mntnc Req		
RMTCECTR		Mntnc Ctl		

FACILITY PRINCIPAL FUNCTIONS		
REQUIREMENT	DESCRIPTION	SPECIFICATION
	Radiates ATS voice information to aircraft or ground vehicle through VHF/UHF radio link Transmission is remotely controlled Receivers are controlled by aircraft R.F. carrier Maintenance Remotely Controlled Radiates a signal to selectively address a specific aircraft Receives aircraft message and relays voice Receiver Controls Runway Lights	

FUNCTIONAL OUTPUTS				
LOC	NAME	STANDARD	TO	LOC
	ATC Comm		ACC	
	ATC Comm		FSS	
	PushToTalk		ACC	
	PushToTalk		TCU	
	PushToTalk		THR	
	PushToTalk		FSS	
	SELCAL		AIRCRAFT	
	RmoteLight			
	Mntnc Data		RMTCECTR	
	ConComf		ACC	
	ConComf		TCU	
	ConComf		THR	
	ConComf		FSS	

EQUIPMENT TYPES	
o	o
o	o
o	o
o	o
o	o
o	o

FIGURE 4-8

CANADIAN AIRSPACE SYSTEM
SYSTEM DESIGN
LEVEL ONE

SEPTEMBER 1985

4.2.1.1 - 4.2.1.X (Single Channel VHF/UHF Equipment Descriptions
to be supplied during next phase)

4.2.2 MULTI-CHANNEL VHF/UHF

PURPOSE

The Multi-Channel VHF/UHF facility provides multi-function communications to air traffic facilities to deliver such services as ground control, clearance delivery, Visual Flight Rules (VFR) advisories, departure and arrival, Automated Terminal Information System (ATIS), Transcribed Weather Broadcast (TWB), Automated Weather Observation and Reporting (AWORS), and sectorized enroute information.

FUNCTION

The following are functions of the Multi-Channel VHF/UHF facility:

- Processes, transmits, and receives VHF/UHF voice communications between aircraft under Visual Flight Rules (VFR) and Instrument Flight Rules (IFR), Area Control Centres, and Flight Service Stations within a specified region.
- Processes alarm functions for transmittal to an Area Maintenance Centre.
- Processes operational control functions.
- Transmits maintenance data to an Area Maintenance Centre for equipment certification and trend analysis.

MULTI-CHANNEL VHF/UHF

FUNCTIONAL INPUTS

FROM	LOC	NAME	STANDARD	LOC
AWORS		Now Wx		
TWR		ATIS VC		
FSS		TWB		
ACC		ATC Comm		
TCU		ATC Comm		
TWR		ATC Comm		
FSS		ATC Comm		

FACILITY PRINCIPAL FUNCTIONS

REQUIREMENT	DESCRIPTION	SPECIFICATION
	Radiates ATS voice information to aircraft or ground vehicle through VHF/UHF radio link	
	Transmission is remotely controlled	
	Receivers are controlled by aircraft R.F. carrier	
	Maintenance Remotely Controlled	
	Radiates a signal to selectively address a specific aircraft	
	Receives aircraft message and relays voice	
	Receiver Controls Runway Lights	
	Broadcast Weather Information	
	Broadcast ATIS	

FUNCTIONAL OUTPUTS

LOC	NAME	STANDARD	TO	LOC
	ATIS Bcst		AIRCRAFT	
	TWB Bcst		AIRCRAFT	
	ATC Comm		ACC	
	ATC Comm		TCU	
	ATC Comm		FSS	

EQUIPMENT TYPES

o Receivers and Transmitters	o
	o
o Antennas	o
o Maintenance Processor	o
	o
o	o

FIGURE 4-9

CANADIAN AIRSPACE SYSTEM
SYSTEM DESIGN
LEVEL ONE

SEPTEMBER 1985

4.2.2.1 - 4.2.2.X (Multi-Channel VHF/UHF Equipment Descriptions to be supplied during next phase)

4.2.3 HIGH FREQUENCY (HF) COMMUNICATIONS

PURPOSE

The High Frequency (HF) Communications facility provides air/ground communications coverage over Canada's Northern Airspace and the North Atlantic Tracks of the Oceanic Airspace. In the Northern Airspace it supplements VHF communications and provides services at lower altitudes. It also provides data communications for dependent surveillance.

FUNCTION

The following are functions of High Frequency (HF) Communications facility:

- Processes, transmits, and receives HF voice communications between aircraft under Visual Flight Rules (VFR) and Instrument Flight Rules (IFR), Area Control Centres, and Flight Service Stations within a specified region.
- Processes alarm functions for transmittal to an Area Maintenance Centre.
- Processes operational control functions.
- Transmits maintenance data to an Area Maintenance Centre for equipment certification and trend analysis.

HIGH FREQUENCY (HF) COMMUNICATIONS

FUNCTIONAL INPUTS				
FROM	LOC	NAME	STANDARD	LOC
FSS		ATCComm VC		
AIRCRAFT		ATCComm VC		
ACC		ATCComm DA		
GANDFSS		ATCComm DA		
AIRCRAFT		ATCComm DA		
FSS		SELCAL		
FSS		PushToTalk		
GANDFSS		PushToTalk		
RMTCECTR		Equip Ctl		

FACILITY PRINCIPAL FUNCTIONS		
REQUIREMENT	DESCRIPTION	SPECIFICATION
	Radiate FSS Voice Information to Aircraft	
	Address Specific Aircraft (SELCAL)	
	Radiate ATS Data to Specific Aircraft (data link)	
	Facility Remotely Controlled	
	Receivers Controlled by Aircraft R.F. Carrier	
	Receive Aircraft Transmissions and Relay Voice and Data	
	Maintenance Certification and Status Remotely Controlled	

FUNCTIONAL OUTPUTS				
LOC	NAME	STANDARD	TO	LOC
	ATCComm VC		FSS	
	ATCComm VC		AIRCRAFT	
	ATCComm VC		ACC	
	ATCComm DA		AIRCRAFT	
	SELCAL		AIRCRAFT	
	PushToTalk		FSS	
	Equip Stat		RMTCECTR	
	CtlConfirm		ACC	
	CtlConfirm		FSS	
	CtlConfirm		RMTCECTR	

EQUIPMENT TYPES

o HF Transmitters
o HF Receivers
o Voice/Data Modems
o Communications Processors
o Status Monitor
o Antennas
o
o
o
o
o

FIGURE 4-10

CANADIAN AIRSPACE SYSTEM
SYSTEM DESIGN
LEVEL ONE

SEPTEMBER 1985

4.2.3.1 - 4.2.3.X (High Frequency (HF) Communications Equipment Descriptions to be supplied during next phase)

4.2.4 SATELLITE COMMUNICATIONS

PURPOSE

Satellite Communications facilities provide both voice and data air-ground communications to deliver such services as independent and dependent surveillance clearance delivery and weather.

FUNCTION

The ground station processes all air-ground communications received from or transmitted to the satellite which includes processing all ranging information for the dependent surveillance function, processing alarm functions for transmittal to the Area Maintenance Centre, and processing control functions and maintenance data.

SATELLITE COMMUNICATIONS

FUNCTIONAL INPUTS				
FROM	LOC	NAME	STANDARD	LOC
ACC		ATCComm DA		
FSS		ATCComm DA		
AIRCRAFT		ATCComm DA		
ACC		ATCComm VC		
FSS		ATCComm VC		
RMTCECTR		Mntnc Req		
RMTCECTR		Mntnc Ctl		

FACILITY PRINCIPAL FUNCTIONS		
REQUIREMENT	DESCRIPTION	SPECIFICATION
	Radiates ATS voice information to aircraft	
	Radiates ATS data to aircraft	
	Receives aircraft transmissions and relays voice and data	
	Maintenance of ground station remotely controlled	

FUNCTIONAL OUTPUTS				
LOC	NAME	STANDARD	TO	LOC
	ATCComm DA		ACC	
	ATCComm DA		AIRCRAFT	
	ATCComm VC		ACC	
	Surv Data		AIRCRAFT	
	Mntnc Data		RMTCECTR	
	ConComf		RMTCECTR	

EQUIPMENT TYPES

- o Receivers and Transmitters
- o Communications Processor
- o Maintenance Monitor
- o Voice/Data Modems
- o
- o
- o
- o
- o
- o

FIGURE 4-11

CANADIAN AIRSPACE SYSTEM
SYSTEM DESIGN
LEVEL ONE

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4.2.4.1 - 4.2.4.X (Satellite Communications Equipment Descriptions to be supplied during next phase)

4.3 NAVIGATION FACILITIES

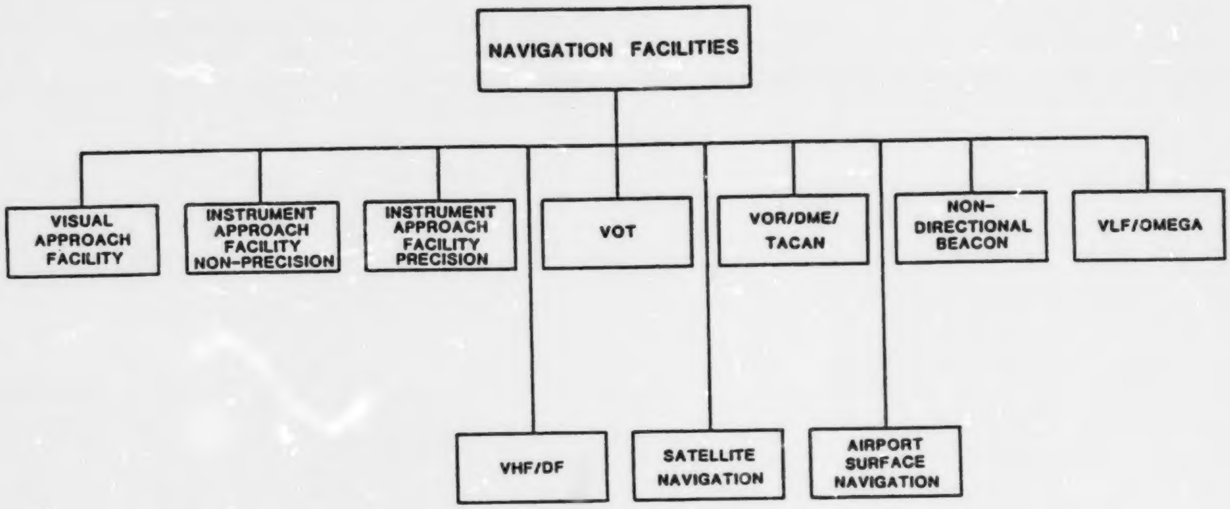
NAVIGATION FACILITIES
VISUAL APPROACH FACILITY
INSTRUMENT APPROACH FACILITY NON-PRECISION
INSTRUMENT APPROACH FACILITY PRECISION
VOT
VOR/DME/ TACAN
NON-DIRECTIONAL BEACON
VLF/OMEGA
VHF/DF
SATELLITE NAVIGATION
AIRPORT SURFACE NAVIGATION

FIGURE 4-12

DESCRIPTION

Navigation facilities include all facilities in the Air Navigation System in Canada which provide aircraft with enroute and approach and landing guidance.

The enroute navigation facilities equipment includes: Very High Frequency Omni-directional Range (VOR, Tactical Air Navigation (TACAN), and Distance Measuring Equipment (DME) for airways network guidance, Non-Directional Beacon (NDB) for bearing position determination, and Direction Finder (DF) for emergency locating of aircraft by ground-based equipment. Also included is the VHF Omni-directional Range Test (VOT) facility which enables preflight and, in some cases, airborne calibration of VOR avionics.

Precision approach and landing facilities equipment includes the Instrument Landing System (ILS) or Microwave Landing System (MLS) which provides electronic approach, landing, and, in some cases, rollout, missed approach, or departure guidance, together with visual approach facilities including High Intensity Approach Lights (HIAL), High Intensity Runway Lights (HIRL), and Runway Touchdown Zone and Centerline Lighting (TDZ/CL) for Category II operations.

Non-precision landing facilities equipment may include combinations of enroute navigation facilities and ILS localizers or MLS azimuth units for electronic guidance together with medium or high intensity approach, and runway lighting.

Visual approach path guidance is provided by a Visual Approach Slope Indicator (VASI) or a Precision Approach Path Indicator (PAPI) or a Pulse Light Approach Slope Indicator (PLASI).

4.3.1 VISUAL APPROACH FACILITY

PURPOSE

The Visual Approach Facility provides visual descent guidance to the pilot during the approach phase of flight. It may also convey additional visual information defining the runway and provide alignment, heighth, and horizontal references.

FUNCTION

The Visual Approach Facility consists of a Visual Approach Slope Indicator (VASI) System providing an indication of descent angle by means of white and red light projections along the desired descent path to the touchdown point. The VASI may be replaced with more modern systems such as the Precision Approach Path Indicator (PAPI) System or Pulse Light Approach Slope Indicator (PLASI) System which will provide improved visual guidance.

If night operations are desired, Medium Intensity Runway Lighting (MIRL) System will be required to define the runway and to provide the pilot with visual information regarding runway alignment, heighth perception, roll-out (flare) guidance, and horizontal reference.

Runway-end Identification Light System (RILS) will also be provided in special circumstances, e.g., when contrast with other lighting or surrounding terrain is lacking.

Lead In Lighting (LDIN) Systems will also be provided where special problems exist due to hazardous terrain, obstructions, or noise abatement restrictions.

INTERFACES

Visual Approach Facility/Pilot. The Visual Approach Facility will provide visual guidance on approach and landing to the aircraft pilot. The pilot may request changes to intensity of portions of the lighting at the facility.

Visual Approach Facility/Control Tower/Flight Service Station. The facility on/off status will be controlled and monitored by the air traffic controller or flight service specialist.

Visual Approach Facility/Control and Performance Monitoring System (CPMS). The facility will provide status information to the CPMS and the CPMS may control or adjust the facility when authorized.

The equipment descriptions and functions for the Visual Approach Facility are described in section 4.3.4 of this document.

VISUAL APPROACH FACILITY

FUNCTIONAL INPUTS				
FROM	LOC	NAME	STANDARD	LOC
TWR		Request	TESP	
FSS		Request	TESP	
AMTCECTR		Request	TESP	
TWR		Command	TP312E TP642 TP1838	
FSS		Command	TP312E TP642 TP1838	
AIRCRAFT		Command	TP312E TP642 TP1838	

FACILITY PRINCIPAL FUNCTIONS		
REQUIREMENT	DESCRIPTION	SPECIFICATION
	Provide visual descent information to a pilot during approach	
	Provide visual reference indications to the pilot	
	Provide special lighting for contrast obstruction problems	

FUNCTIONAL OUTPUTS				
LOC	NAME	STANDARD	TO	LOC
	Status	TESP	AMTCECTR	
	Status	TESP	TWR	
	Status	TESP	FSS	
	Vis Gd App	TP312E	AIRCRAFT	
	Vis Gd Rwy	TP312E	AIRCRAFT	

EQUIPMENT TYPES	
o VASI, PAPI, or PLASI	o
o MIRL (Optional)	o
o REIL (Optional)	o
o LDIN (Optional)	o
o	o
o	o

FIGURE 4-13

4.3.2 INSTRUMENT APPROACH FACILITY - NON-PRECISION

PURPOSE

The Non-Precision Instrument Approach Facility is provided to allow approaches to be made under Instrument Flight Rules (IFR) operations by means of additional electronic and visual aids. This facility is the most basic of the electronically enhanced approach facilities and does not provide full reduction in operating limits.

FUNCTION

The IFR Non-Precision Instrument Approach Facility will consist of some combination of Non-Directional Beacons (NDB), Very High Frequency Omni-Ranges (VOR), Instrument Landing System Localizers (LOC) with front or back course coverage, Microwave Landing System (MLS) Azimuth Units, Distance Measuring Equipment/Non-Precision (DME/N), Distance Measuring Equipment/Precision (DME/P), and Instrument Landing System (ILS) Markers, supported by visual aids consisting of Visual Approach Slope Indicator (VASI) System, Precision Approach Path Indicators (PAPI) System, Pulse Light Approach Slope Indicator (PLASI) System, Medium Intensity Runway Lighting (MIRL) System, and Low Intensity Approach Lighting (LIAL) System. As with the Visual Approach Facility, Runway-end Identification Light System (RILS) and Lead In Lighting (LDIN) Systems may be installed to address specific problems that may exist with visibility or obstructions.

In the basic guidance system, the NDB provides a minimum ceiling limit of as low as 350 feet. Lower operating limits may be achieved by replacing the NDB with a VOR, a Localizer (front or back course), or an MLS Azimuth Unit. The lowest non-precision limit obtainable will be achieved with the combination of a Localizer or MLS Azimuth Unit and a DME/N or DME/P.

INTERFACES

Non-Precision Instrument Approach Facility/Aircraft Receiver. The facility will provide electronic information to the aircraft receiver via radio signals to be used for approach guidance.

Non-Precision Instrument Approach Facility/Control Tower/Flight Service Station. The facility on/off status will be controlled and monitored by the air traffic controller or flight service specialist.

Non-Precision Instrument Approach Facility/Pilot. Visual portions of the facility will provide visual approach and landing guidance to the pilot. The pilot may request changes to intensity of portions of the lighting.

Non-Precision Instrument Approach Facility/Control and Performance Monitoring System (CPMS). The facility will provide status information to the CPMS and the CPMS may control or adjust the facility when authorized.

The equipment descriptions and functions for the Non-Precision Instrument Approach Facility are described in section 4.3.4 of this document.

INSTRUMENT APPROACH FACILITY - NON-PRECISION

FUNCTIONAL INPUTS				
FROM	LOC	NAME	STANDARD	LOC
TWR		Request	TESP	
FSS		Request	TESP	
AMTCECTR		Request	TESP	
TWR		Command	TP312E	
FSS		Command	TP312E	
AIRCRAFT		Command	TP312E	

FACILITY PRINCIPAL FUNCTIONS		
REQUIREMENT	DESCRIPTION	SPECIFICATION
	Provide visual approach guidance Provide electronic approach guidance (position fix or azimuth and distance)	

FUNCTIONAL OUTPUTS				
LOC	NAME	STANDARD	TO	LOC
	Azimuth Gd	ICAO 10	AIRCRAFT	
	DistanceGd	ICAO 10	AIRCRAFT	
	FacilityID	ICAO 10	AIRCRAFT	
	Site Data	ICAO 10	AIRCRAFT	
	Status	TESP	AMTCECTR	
	Status	TESP	TWR	
	Status	TESP	FSS	
	Vis Gd App	TP1838	AIRCRAFT	
	Vis Gd Rwy	TP312E	AIRCRAFT	

EQUIPMENT TYPES

o MIRL
o LDIN
o VASI, PAPI, or PLASI
o NDB, VOR, LOC,
  LOC/DME, AZ, or
  AZ/DME
o LIAL
o
o
o
o
o

FIGURE 4-14

CANADIAN AIRSPACE SYSTEM
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4.3.3 INSTRUMENT APPROACH FACILITY - PRECISION

PURPOSE

The Precision Instrument Approach Facility provides the lowest landing limits obtainable under Instrument Flight Rules (IFR). Depending upon category, guidance can be provided down to and along the runway so that completely automated landings could be undertaken.

FUNCTION

Precision Instrument Approach Facilities will provide approach, landing, and, in some cases, roll-out and missed approach guidance. The basic guidance systems providing the azimuth, elevation, and distance information are the Instrument Landing System (ILS) and Microwave Landing System (MLS). These systems are functionally equivalent, although there are differences in performance, flexibility, and precision. MLS, the more advanced system, was adopted by the International Civil Aviation Organization (ICAO) to replace ILS as the world standard landing aid. New or replacement systems provided during the 1990's will be MLS and subsequent to the year 2000, all systems will be MLS.

There are three categories of precision instrument approach: Category I, II, and III. As the equipment lists differ somewhat for each category, they will be addressed separately.

Category I: The basic requirements for Category I operations are as follows; an ILS or MLS system (Category I performance limits or better) and a Runway Visual Range (RVR) System. The associated visual aids are; High Intensity Runway Lighting (HIRL) System and High Intensity Approach Lighting (HIAL) System. As for the non-precision approaches, Lead In Lighting (LDIN) Systems and Runway-end Identification Light System (RILS) will be provided to address specific approach conditions.

Category II: A Category II quality ILS or an MLS must be provided to fulfill the electronic guidance requirements. The associated visual aids are; HIRL, Runway Touchdown Zone and Centerline Lighting (TDZ/CL) Systems, Category II approach lighting, and two RVR systems.

Category III: At this time there are no definitive plans for Category III operations in Canada.

INTERFACES

Guidance Equipment/Pilot. The electronic guidance equipment (ILS, MLS, DME) provide the pilot with the azimuth, elevation, and distance guidance information necessary to conduct approaches and landings under Instrument Flight Rule (IFR) conditions. The guidance signals are received by the respective airborne receivers, processed, and presented to the pilot on his flight instruments. In addition, these signals may be used by the autopilot (flight director) to provide a coupled approach and, in some circumstances, landing capability.

The various approach, runway, and special purpose lighting configurations available are provided to offer visual reference information and guidance to the pilot for completion of approach and landing under differing visibility conditions.

Guidance Equipment/Control and Performance Monitoring System (CPMS)/Air Traffic Service (ATS). All equipment will have a CPMS interface which will allow performance monitoring, certification, and control from centralized work areas. Direct control of the equipment will be provided to the ATS where there is an ATS facility at the airport.

The equipment descriptions and functions for the Non-Precision Instrument Approach Facility are described in section 4.3.4 of this document.

INSTRUMENT APPROACH FACILITY - PRECISION

FUNCTIONAL INPUTS

FROM	LOC	NAME	STANDARD	LOC
TWR		Request	TESP	
FSS		Request	TESP	
AMTCECTR		Request	TESP	
TWR		Command	TP312E	
FSS		Command	TP312E	
AIRCRAFT		Command	TP312E	

FACILITY PRINCIPAL FUNCTIONS

REQUIREMENT	DESCRIPTION	SPECIFICATION
	Provide azimuth information to runway centerline (MLS - pilot selectable)	
	Provide descent angle information (MLS - pilot selectable)	
	Provide distance information (ILS - MKR Standard DME/N Optional MLS - DME/P Standard	
	Maintenance monitoring	
	Approach Visual Guidance	
	Runway Visual Guidance	
	Horizontal visibility information	
	Basic airport data to aircraft (MLS only) (optional VHF control of lighting)	

FUNCTIONAL OUTPUTS

LOC	NAME	STANDARD	TO	LOC
	Azimuth Gd	ICAO 10	AIRCRAFT	
	Elev Guide	ICAO 10	AIRCRAFT	
	Dist Guide	ICAO 10	AIRCRAFT	
	FacilityID	ICAO 10	AIRCRAFT	
	Site Data	ICAO 10	AIRCRAFT	
	Status	TESP	AMTCECTR	
	Status	TESP	TWR	
	Status	TESP	FSS	
	RVR Level	TESP	TWR	
	RVR Level	TESP	FSS	
	Vis Gd App	TP1838	AIRCRAFT	
	Vis Gd Rwy	TP312E	AIRCRAFT	

EQUIPMENT TYPES

- o ILS - PHL7002, 7404, 7801
- o DME - RYC7005, 7502, 7704, 8102
- o RVR - PEP8303 Transmissometer CVD8404 RVR Computer
- o

- o HIAL
- o HIRL
- o MITE
- o Airport Beacon
- o Apron Lighting
- o TDZ/CL
- o MLS
- o
- o

FIGURE 4-15

4.3.4 APPROACH FACILITY EQUIPMENT DESCRIPTIONS

4.3.4.1 Low Intensity Approach Lighting (LIAL) System

PURPOSE

The Low Intensity Approach Lighting (LIAL) System will consist of a series of lights that provide the pilot with visual guidance on non-precision Instrument Flight Rules (IFR) runways.

FUNCTION

Low intensity approach lights will be installed as nearly to the horizontal as feasible on the extended centre line of the runway, extending over a distance of 900 metres from the runway threshold. The lights forming the centre line will be placed at longitudinal intervals of 60 meters (200 feet) and the row of lights will commence 60 metres (200 feet) from the threshold. Each lighting unit will consist of a twin unit fixture. The lights will be fixed and coloured aviation yellow.

INTERFACES

Low Intensity Approach Light (LIAL)/Control Tower/Flight Service Station. This interface will provide the air traffic controller and flight service specialist in the Control Tower and Flight Service Station with operational control of the LIAL which, in this case will be limited to on/off control. Operational information concerning on/off status and/or intensity level on any system or lamp failure condition will be available to the Control Tower or Flight Service Station through the Control and Performance Monitoring System (CPMS).

Low Intensity Approach Light (LIAL)/Control and Performance Monitoring System (CPMS). The LIAL will have a Remote Monitoring System (RMS) which will monitor such parameters as current, voltage, and on/off status. The interface with the LIAL RMS will normally be through the Regional Maintenance Centre. In addition to providing equipment status and alarm information for maintenance purposes, operational status of the lights will be determined and provided to the Terminal Control Unit (TCU) Common Controller Workstation. Should the airport be unmanned and control be transferred to the Area Control Centre Common Controller Workstation, operational status information will be provided to the Area Control Centre Common Controller Workstation via the Control and Performance Monitoring System (CPMS) and computer centre while operational control will be given directly to the pilot through use of the aircraft's VHF transceiver.

Low Intensity Approach Light (LIAL)/Pilot. This interface will be visual only and will provide the pilot with the visual guidance necessary to assist in the approach and landing phases of operation.

Low Intensity Approach Light (LIAL)/VHF Transceiver. In the event an airport is unmanned, a capability will exist for the pilot to control the on/off status of the LIAL via the VHF transceiver in the aircraft. This will be accomplished by tuning the transceiver to the specified VHF frequency and keying the microphone the required number of times within a 5-second interval in accorance with specified procedures. These transmitter pulses or clicks will be received by a VHF radio control unit within the LIAL where they will be decoded and utilized to energize relays. These relays control the lighting system and remain energized for a period of 15 minutes from the most recent activation unless subsequent pulses are received to change the activation relays.

LOW INTENSITY APPROACH LIGHTING (LIAL)

FUNCTIONAL INPUTS				
FROM	LOC	NAME	STANDARD	LOC
TWR		REQUEST	TESP	
FSS		REQUEST	TESP	
AMTCECTR		REQUEST	TESP	
TWR		COMMAND	TP312E	
FSS		COMMAND	TP312E	
AIRCRAFT		COMMAND	TP312E	

FACILITY PRINCIPAL FUNCTIONS		
REQUIREMENT	DESCRIPTION	SPECIFICATION
	Provides the pilot with circling, offset, and straight-in guidance for a non-precision approach runway	
	Maintenance monitoring	

FUNCTIONAL OUTPUTS				
LOC	NAME	STANDARD	TO	LOC
	STATUS	TESP	TWR	
	STATUS	TESP	FSS	
	STATUS	TESP	AMTCECTR	
	VIZ CMD	TP312E TP308	AIRCRAFT	

EQUIPMENT TYPES	
o	o
o	o
o	o
o	o
o	o
o	o

FIGURE 4-16

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4.3.4.2 High Intensity Approach Lighting (HIAL) System - Category I

PURPOSE

The High Intensity Approach Lighting (HIAL) System will consist of a series of lights that provide the pilot with visual guidance on Instrument Flight Rules (IFR) Category I runways.

FUNCTION

A high intensity approach light system Category I will consist of a row of lights on the extended centre line of the runway, extending over a distance of 900 metres (3,000 feet) from the runway threshold. The centre line units will consist of barrettes 6 metres (20 feet) wide spaced at longitudinal intervals of 30 metres (100 feet) commencing 90 metres (300 feet) from the threshold. Each barrette will consist of 5 units (white) spaced laterally at 1.5 metres (5 feet) intervals. The threshold will be indicated by two groups of green lights commencing at the runway edge and disposed symmetrically abouth the runway centre line uniformly spaced in each group with a gap equal to not more than one half the runway width. (Green/red) runway combined threshold and end light units will be interspaced between the green threshold light units with the outermost light units located 1.5 metres (5 feet) beyond the runway edge. Two contrast bars, each 6 metres (20 feet) in width, will be placed at a longitudinal distance of 30 metres (100 feet) from the threshold. Each bar will consist of 5 units (aviation red) spaced laterally at 1.5 metres (5 feet) intervals commencing from the extended edge line of the runway. The imminence of threshold bar, 21 metres (70 feet) in width, will be placed in a horizontal straight line at right angles to and bisected by the extended centre line of the runway at a longitudinal distance of 60 meters (200 feet) from the threshold. The bar will consist of 15 units (aviation red), spaced laterally at 1.5 metres (5 feet) intervals.. A cross bar, 39 metres (130 feet) in width, will be placed in a horizontal stright line at right angles to and bisected by the extended centre line of the runway at a longitudinal distance of 300 metres (1000 feet) from the threshold. The cross bar will consist of 27 units (white), spaced laterally at 1.5 metres (5 feet) intervals. The approach light system will lie as nearly to the horizontal as feasible.

INTERFACES

High Intensity Approach Light (HIAL)/Control Tower/Flight Service Station. This interface will provide the air traffic controller and flight service specialist with operational control of the HIAL intensity levels and on/off functions. Operational information related to the on/off status, intensity level selected, or any occurrence of lamp failures will be available to the Control Tower or Flight Service Station through the Control and Performance Monitoring System (CPMS).

High Intensity Approach Light (HIAL)/Control and Performance Monitoring System (CPMS). The HIAL will have a Remote Monitoring System (RMS) which will monitor such things as current, voltage, and on/off status. The interface with the HIAL RMS would normally be with a Regional Maintenance Centre. In addition to providing equipment status and alarm information for maintenance purposes, operational status of the lights will be determined and provided to the Control Tower or Flight Service Station. Should the airport be unmanned and control transferred to the Area Control Centre (ACC), operational status information will be provided to the ACC via the CPMS and computer centre while operational control will be given directly to the pilot through the use of the aircraft's VHF transceiver.

High Intensity Approach Light (HIAL)/Pilot. This interface will be visual only and will provide the pilot with the visual guidance necessary to assist in the approach and landing phases of operation.

High Intensity Approach Light (HIAL)/VHF Transceiver. In the event an airport is unmanned, a capability will exist for the pilot to control the on/off status of the HIAL via the VHF transceiver in the aircraft. This will be accomplished by tuning the transceiver to the specified VHF frequency and keying the microphone the required number of times within a 5-second interval in accorance with specified procedures. These transmitter pulses or clicks will be received by a VHF radio control unit within the HIAL where they will be decoded and utilized to energize relays. These relays control the lighting system and remain energized for a period of 15 minutes from the most recent activation unless subsequent pulses are received to change the activation relays.

HIGH INTENSITY APPROACH LIGHTING - CATEGORY I

FUNCTIONAL INPUTS				
FROM	LOC	NAME	STANDARD	LOC
TWR		Request	TESP	
FSS		Request	TESP	
AMTCECTR		Request	TESP	
TWR		Command	TP312E	
FSS		Command	TP312E	
AIRCRAFT		Command	TP312E	

FACILITY PRINCIPAL FUNCTIONS		
REQUIREMENT	DESCRIPTION	SPECIFICATION
	Provides visual approach and landing guidance to the pilot	
	Maintenance monitoring	

FUNCTIONAL OUTPUTS				
LOC	NAME	STANDARD	TO	LOC
	Status	TESP	TWR	
	Status	TESP	FSS	
	Status	TESP	AMTCECTR	
	VizCmd	TESP	AIRCRAFT	
	Status	TESP	RVR	

EQUIPMENT TYPES	
○	○
○	○
○	○
○	○
○	○
○	○

FIGURE 4-17

4.3.4.3 High Intensity Approach Lighting (HIAL) System - Category II

PURPOSE

The High Intensity Approach Lighting (HIAL) System will consist of a series of lights that provide the pilot with visual guidance on Instrument Flight Rules (IFR) Category II runways.

FUNCTION

A high intensity approach light system Category II will consist of a row of lights on the extended centre line of the runway, extending for a distance of 900 metres (3000 feet) from the runway threshold. The centre line units will consist of barrettes 6 metres (20 feet) in width spaced at longitudinal intervals of 30 metres (100 feet) commencing 30 metres (100 feet) from the threshold. Each barrette will consist of 5 units (white), spaced laterally at 1.5 metres (5 feet) intervals. The threshold will be indicated by green light units uniformly spaced at intervals of 3 metres (10 feet) commencing at the runway edges. Left and right wing bars will be placed along the extended threshold line on each side of the runway commencing 2.7 meters (9 feet) from the runway edge consisting of 11 units (aviation green) spaced laterally at 1.2 meteres (4 feet) intervals. (Green/red) runway combined threshold and end units will be interspaced between the green threshold light units with the outermost light units located 1.5 metres (5 feet) beyond the runway edges. A cross bar, 24 metres (80 feet) in width, will be placed in a horizontal straight line at right angles to and bisected by the extended centre line of the runway at a longitudinal distance of 150 metres (500 feet) from the threshold. It will consist of 17 units, 11 white and 6 red spaced laterally at 1.5 meteres (5 feet) intervals. A cross bar, 40 metres (130 feet) in width, will be placed in a horizontal straight line at right angles to and bisected by the extended centre line of the runway at a longitudinal distance of 300 metres (1000 feet) from the threshold. It will consist of 27 units (white), spaced laterally at 1.5 metres (5 feet) intervals. The approach light system will lie as nearly to the horizontal as feasible.

INTERFACES

Category II Approach Lighting/Control Tower/Flight Service Station. This interface will provide the air traffic controller and flight service specialist with operational control of the Category II Approach Lighting intensity levels and on/off functions. Operational information related to the on/off status, intensity level selected, or any occurrence of lamp failures will be available to the Control Tower or Flight Service Station through the Control and Performance Monitoring System (CPMS).

Category II Approach Lighting/Control and Performance Monitoring System (CPMS). The Category II Approach Lighting will have a Remote Monitoring System (RMS) which will monitor such things as current, voltage, and on/off status. The interface with the Category II Approach Lighting RMS would normally be with a Regional Maintenance Centre. In addition to providing equipment status and alarm information for maintenance purposes, operational status of the lights will be determined and provided to the Control Tower or Flight Service Station. Should the airport be unmanned and control transferred to the Area Control Centre (ACC), operational status information will be provided to the ACC via the CPMS and computer centre while operational control will be given directly to the pilot through the use of the aircraft's VHF transceiver.

Category II Approach Lighting/Pilot.
This interface will be visual only and will provide the pilot with the visual guidance necessary to assist in the approach and landing phases of operation.

HIGH INTENSITY APPROACH LIGHTING - CATEGORY II

FUNCTIONAL INPUTS				
FROM	LOC	NAME	STANDARD	LOC
TWR		Request	TESP	
FSS		Request	TESP	
AMTCECTR		Request	TESP	
TWR		Command	TP312E	
FSS		Command	TP312E	
AIRCRAFT		Command	TP312E	

FACILITY PRINCIPAL FUNCTIONS		
REQUIREMENT	DESCRIPTION	SPECIFICATION
	Provides visual approach and landing guidance to the pilot	
	Maintenance monitoring	

FUNCTIONAL OUTPUTS				
LOC	NAME	STANDARD	TO	LOC
	Status	TESP	TWR	
	Status	TESP	FSS	
	Status	TESP	AMTCECTR	
	VizCmd	TESP	AIRCRAFT	
	Status	TESP	RVR	

EQUIPMENT TYPES	
o	o
o	o
o	o
o	o
o	o
o	o

FIGURE 4-18

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4.3.4.4 Medium Intensity Runway Lighting (MIRL) System

PURPOSE

The Medium Intensity Runway Lighting (MIRL) System will consist of a series of lights that provide the pilot with visual guidance on Visual Flight Rules (VFR) and Non-Precision Instrument Flight Rules (IFR) runways.

FUNCTION

Medium intensity runway edge lights will be variable intensity, white, and will be placed along the full length of the runway in two parallel straight lines equidistant from the runway centre line. The lines of lights will be placed 1.5 metres (5 feet) from the edge of the runway and the longitudinal distance between the lights will not be greater that 60 metres (200 feet). At intersections of runways, the lights may be irregularly spaced or omitted, but the extended spacing will not be greater than 120 metres (400 feet).

INTERFACES

Medium Intensity Runway Lighting (MIRL)/Control Tower/Flight Service Station. This interface will provide the air traffic controller and flight service specialist with operational control of the MIRL intensity levels and on/off functions. Operational information related to the on/off status, intensity level selected, or any occurrence of lamp failures will be available to the Control Tower or Flight Service Station through the Control and Performance Monitoring System (CPMS).

Medium Intensity Runway Lighting (MIRL)/Control and Performance Monitoring System (CPMS). The MIRL will have a Remote Monitoring System (RMS) which will monitor such things as current, voltage, and on/off status. The interface with the MIRL RMS would normally be with a Regional Maintenance Centre. In addition to providing equipment status and alarm information for maintenance purposes, operational status of the lights will be determined and provided to the Control Tower or Flight Service Station. Should the airport be unmanned and control transferred to the Area Control Centre (ACC), operational status information will be provided to the ACC via the CPMS and computer centre while operational control will be given directly to the pilot through the use of the aircraft's VHF transceiver.

Medium Intensity Runway Lighting (MIRL)/Pilot. This interface will be visual only and will provide the pilot with the visual guidance necessary to assist in the approach and landing phases of operation.

Medium Intensity Runway Lighting (MIRL)/VHF Transceiver. In the event an airport is unmanned, a capability will exist for the pilot to control the on/off status of the MIRL via the VHF transceiver in the aircraft. This will be accomplished by tuning the transceiver to the specified VHF frequency and keying the microphone the required number of times within a 5-second interval in accorance with specified procedures. These transmitter pulses or clicks will be received by a VHF radio control unit within the MIRL where they will be decoded and utilized to energize relays. These relays control the lighting system and remain energized for a period of 15 minutes from the most recent activation unless subsequent pulses are received to change the activation relays.

MEDIUM INTENSITY RUNWAY LIGHTING (MIRL)

FUNCTIONAL INPUTS				
FROM	LOC	NAME	STANDARD	LOC
TWR		Request	TESP	
FSS		Request	TESP	
AMTCECTR		Request	TESP	
TWR		Command	TP312E	
FSS		Command	TP312E	
AIRCRAFT		Command	TP312E	

FACILITY PRINCIPAL FUNCTIONS		
REQUIREMENT	DESCRIPTION	SPECIFICATION
	Provides the pilot with visual approach and landing guidance	
	Maintenance monitoring	

FUNCTIONAL OUTPUTS				
LOC	NAME	STANDARD	TO	LOC
	Status	TESP	TWR	
	Status	TESP	FSS	
	Status	TESP	AMTCECTR	
	Viz Cmd		AIRCRAFT	

EQUIPMENT TYPES	
o	o
o	o
o	o
o	o
o	o
o	o

FIGURE 4-19

4.3.4.5 High Intensity Runway Lighting (HIRL) System

PURPOSE

The High Intensity Runway Lighting (HIRL) System will consist of a series of lights that provide the pilot with visual guidance on Instrument Flight Rules (IFR) Category I or Category II runways.

FUNCTION

High intensity runway edge lights will be variable intensity, white, and will be placed along the full length of the runway in two parallel straight lines equidistant from the runway centre line. The lines of lights will be placed 1.5 metres (5 feet) from the edge of the runway and the longitudinal distance between the lights will not be greater than 60 metres (200 feet). At intersections of runways, the lights may be irregularly spaced or omitted, but the extended spacing will not be greater than 120 metres (400 feet).

INTERFACES

High Intensity Runway Lighting (HIRL)/Control Tower/Flight Service Station. This interface will provide the air traffic controller and flight service specialist with operational control of the HIRL intensity levels and on/off functions. Operational information related to the on/off status, intensity level selected, or any occurrence of lamp failures will be available to the Control Tower or Flight Service Station through the Control and Performance Monitoring System (CPMS).

High Intensity Runway Lighting (HIRL)/Control and Performance Monitoring System (CPMS). The HIRL will have a Remote Monitoring System (RMS) which will monitor such things as current, voltage, and on/off status. The interface with the HIRL RMS would normally be with a Regional Maintenance Centre. In addition to providing equipment status and alarm information for maintenance purposes, operational status of the lights will be determined and provided to the Control Tower or Flight Service Station. Should the airport be unmanned and control transferred to the Area Control Centre (ACC), operational status information will be provided to the ACC via the CPMS and computer centre while operational control will be given directly to the pilot through the use of the aircraft's VHF transceiver.

High Intensity Runway Lighting (HIRL)/Pilot. This interface will be visual only and will provide the pilot with the visual guidance necessary to assist in the approach and landing phases of operation.

High Intensity Runway Lighting (HIRL)/VHF Transceiver. In the event an airport is unmanned, a capability will exist for the pilot to control the on/off status of the HIRL via the VHF transceiver in the aircraft. This will be accomplished by tuning the transceiver to the specified VHF frequency and keying the microphone the required number of times within a 5-second interval in accorance with specified procedures. These transmitter pulses or clicks will be received by a VHF radio control unit within the HIRL where they will be decoded and utilized to energize relays. These relays control the lighting system and remain energized for a period of 15 minutes from the most recent activation unless subsequent pulses are received to change the activation relays.

HIGH INTENSITY RUNWAY LIGHTING (HIRL)

FUNCTIONAL INPUTS

FROM	LOC	NAME	STANDARD	LOC
TWR		Request	TESP	
FSS		Request	TESP	
AMTCECTR		Request	TESP	
TWR		Command	TP312E	
FSS		Command	TP312E	
AIRCRAFT		Command	TP312E	

FACILITY PRINCIPAL FUNCTIONS

REQUIREMENT	DESCRIPTION	SPECIFICATION
	Provides visual approach and landing guidance to the pilot	
	Maintenance monitoring	

FUNCTIONAL OUTPUTS

LOC	NAME	STANDARD	TO	LOC
	Status	TESP	TWR	
	Status	TESP	FSS	
	Status	TESP	AMTCECTR	
	Viz Cmd		AIRCRAFT	
	Status	TESP	RVR	

EQUIPMENT TYPES

o	o
o	o
o	o
o	o
o	o
o	

FIGURE 4-20

4.3.4.6 Runway Touchdown Zone and Centerline Lighting (TDZ/CL) Systems

PURPOSE

The Runway Touchdown Zone and Centerline Lighting (TDZ/CL) Systems will consist of groups of lights that provide the pilot with visual guidance at touchdown and along the runway centerline at Instrument Flight Rules (IFR) Category II runways.

FUNCTION

Runway centre line lights will be located along the centre line of the runway except that where it is not practicable they may be offsett 600 milimetres (24 inches) laterally from the runway centre line on the non-exit side of the runway. The lights will be placed at longitudinal intervals of approximately 15 metres (50 feet). White runway centre line units will be installed up to a point 900 metres (3,000 feet) from the runway end. The following 600 metres (2,000 feet) will consist of alternate white and red lights. The final 300 metres (1,000 feet) will consist of red lights.

Touchdown zone lights will be formed by pairs of barrettes each consisting of three white lights symmetrically disposed on either side of the runway centre line and inset in the runway. The lights will extend from the threshold for a longitudinal distance of 900 metres (3,000 feet) with the first group of lights commencing 30 metres (100 feet) from the threshold.

INTERFACES

Runway Touchdown Zone and Centerline Lighting (TDZ/CL)/Control Tower/Flight Service Station. This interface will provide the air traffic controller and flight service specialist with operational control of the TDZ/CL intensity levels and on/off functions. Operational information related to the on/off status, intensity level selected, or any occurrence of lamp failures will be available to the Control Tower or Flight Service Station through the Control and Performance Monitoring System (CPMS).

Runway Touchdown Zone and Centerline Lighting (TDZ/CL)/Control and Performance Monitoring System (CPMS). The TDZ/CL will have a Remote Monitoring System (RMS) which will monitor such things as current, voltage, and on/off status. The interface with the TDZ/CL RMS would normally be with a Regional Maintenance Centre. In addition to providing equipment status and alarm information for maintenance purposes, operational status of the lights will be determined and provided to the Control Tower or Flight Service Station. Should the airport be unmanned and control transferred to the Area Control Centre (ACC), operational status information will be provided to the ACC via the CPMS and computer centre while operational control will be given directly to the pilot through the use of the aircraft's VHF transceiver.

Runway Touchdown Zone and Centerline Lighting (TDZ/CL)/Pilot. This interface will be visual only and will provide the pilot with the visual guidance necessary to assist in the approach and landing phases of operation.

RUNWAY TOUCHDOWN ZONE AND CENTERLINE LIGHTING (TDZ/CL)

FUNCTIONAL INPUTS				
FROM	LOC	NAME	STANDARD	LOC
TWR		Request		
FSS		Request		
AMTCECTR		Request		
TWR		Command		
FSS		Command		

FACILITY PRINCIPAL FUNCTIONS		
REQUIREMENT	DESCRIPTION	SPECIFICATION
	Provides visual approach and landing guidance to the pilot	
	Maintenance monitoring	

FUNCTIONAL OUTPUTS				
LOC	NAME	STANDARD	TO	LOC
	Status	TESP	TWR	
	Status	TESP	FSS	
	Status	TESP	AMTCECTR	
	Viz Cmd		AIRCRAFT	
	Status	TESP	RVR	

EQUIPMENT TYPES	
o	o
o	o
o	o
o	o
o	o
o	o

FIGURE 4-21

CANADIAN AIRSPACE SYSTEM
SYSTEM DESIGN
LEVEL ONE

SEPTEMBER 1985

4.3.4.7 Lead In Lighting (LDIN) System

PURPOSE

The Lead In Lighting (LDIN) System will be a configuration of sequenced flashing lights that provide the pilot positive visual guidance along a curved approach path where special problems exist due to hazardous terrain, obstructions, or noise abatement restrictions.

FUNCTION

The Lead In Lighting System will consist of sequenced flashing lamps, fixtures, and necessary power and control devices. A LDIN will be a series of flashing lights installed along the approach path of an airport out to a distance of 3,000 to 5,000 feet from the threshold, at or near ground level. The series or groups of lights are positioned and aimed to be conveniently sighted and followed from the approaching aircraft under conditions at or above approach minimums. Each light group shall contain at least three flashing lights in a linear or cluster arrangement and augmented by steady-burning lights if required. Where practical, the lights in a given group shall flash in sequence toward the runway. The groups shall be spaced closely enough to provide continuous lead-in guidance along each segment of the approach course, terminating at any approved approach lighting system or at an authorized distance from the threshold. Sequencing of successive light groups is also recommended. The basic function of the LDIN is to provide the pilot visual guidance usually along a curved approach path. Lighting control will be available both from the Control Tower or Flight Service Station and, if the airport is unmanned, via VHF radio from an aircraft.

INTERFACES

Lead In Lighting (LDIN)/Control Tower/Flight Service Station. This interface will provide the air traffic controller and flight service specialist with operational control of the LDIN which, in this case, will be limited to on/off control. Operational information concerning on/off status of the system or any system or lamp failure condition will be available to the TWR or FSS through the Control and Performance Monitoring System (CPMS).

Lead In Lighting (LDIN)/Control and Performance Monitoring System (CPMS). The LDIN will have a Remote Maintenance System (RMS) which will monitor such things as current, voltage, flash rate, and on/off status. The interface with the LDIN RMS would normally be with a Area Maintenance Centre. In addition to providing equipment status and alarm information for maintenance purposes, operational status of the lights will be determined and provided to the TWR and FSS. Should the airport be unmanned and control be transferred to the ACC, operational status information will be provided to the ACC via the CPMS and computer center while operational control will be given directly to the pilot through the use of the aircraft's VHF transceiver.

Lead In Lighting (LDIN)/Pilot. This interface will be visual only and provide the pilot with the visual guidance necessary to assist in the approach and landing phases of operation.

Lead In Lighting (LDIN)/VHF Transceiver. In the event an airport is unmanned, a capability will exist for the pilot to control the on/off status of the HIRL via the VHF transceiver in the aircraft. This will be accomplished by tuning the transceiver to the specified VHF frequency and keying the microphone the required number of times within a 5-second interval in accorance with specified procedures. These transmitter pulses or clicks will be received by a VHF radio control unit within the HIRL where they will be decoded and utilized to energize relays. These relays control the lighting system and remain energized for a period of 15 minutes from the most recent activation unless subsequent pulses are received to change the activation relays.

LEAD IN LIGHTING (LDIN)

FUNCTIONAL INPUTS				
FROM	LOC	NAME	STANDARD	LOC

FACILITY PRINCIPAL FUNCTIONS		
REQUIREMENT	DESCRIPTION	SPECIFICATION

FUNCTIONAL OUTPUTS				
LOC	NAME	STANDARD	TO	LOC

EQUIPMENT	
o	o
o	o
o	o
o	o
o	o
o	o

FIGURE 4-22

CANADIAN AIRSPACE SYSTEM
SYSTEM DESIGN
LEVEL ONE

SEPTEMBER 1985

4.3.4.8 Runway-end Identification Light System (RILS)

PURPOSE

The Runway-end Identification Light System (RILS) will identify the approach end of a runway for the pilot.

FUNCTION

The RILS will consist of two flashing light units with self-contained power supply and control. The two synchronized flashing lights, either directional or omnidirectional, will be placed one on each side of the runway landing threshold. If directional lights are used, they must face the approach area. The flashing feature of the lights is intended to attract the attention of the pilot so that he may quickly identify the approach end of the runway, especially when surrounded by a preponderance of other lighting or when contrast with surrounding terrain is lacking. The basic function will be to provide the pilot with a rapid and positive identification of the approach end of the runway. Lighting control will be availabe both from the Control Tower or Flight Service Station and, if the airport is unmanned, via VHF radio from an aircraft.

INTERFACES

Runway-end Identification Light System (RILS)/Control Tower/Flight Service Station. This interface will provide the air traffic controller and flight service specialist with operational control of the RILS which, in this case, will be limited to on/off control. Operational information concerning on/off status of the RILS or any system or lamp failure condition will be available to the TWR and FSS through the Control and Performance Monitoring Syste (CPMS).

Runway-end Identification Light (REIL)/Control and Performance Monitoring System (CPMS). The RILS will have a Remote Monitoring System (RMS) which will monitor such things as current, voltage, flash rate, and on/off status. The interface with the RILS RMS will normally be with the Area Maintenance Centre. In addition to providing equipment status and alarm information for maintenance purposes, operational status of the lights will be determined and provided to the TWR and FSS. Should the airport be unmanned and control be transferred to the ACC, operational status information will be provided to the ACC via the CPMS and computer center while operationa control will be given directly to the pilot through the use of the aircraft's VHF transceiver.

Runway-end Identification Light System (RILS)/Pilot. This interface will be visual only and provide the pilot with a positive visual indication as to the position of the approach end of a runway.

Runway-end Identification Light System (RILS)/VHF Transceiver. In the event an airport is unmanned, a capability will exist for the pilot to control the on/off status of the REIL via the VHF transceiver in the aircraft. This will be accomplished by tuning the transceiver to the specified VHF frequency and keying the microphone the required number of times within a 5-second interval in accordance with specified procedures. These transmitter pulses or clicks will be received by a VHF radio control unit within the REIL where they will be decoded and utilized to energize relays. These relays control the lighting system and remain energized for a period of 15 minutes from the most recent activation unless subsequent pulses are received to change the activation relays.

RUNWAY-END IDENTIFICATION LIGHT SYSTEM (RILS)

FUNCTIONAL INPUTS				
FROM	LOC	NAME	STANDARD	LOC

FACILITY PRINCIPAL FUNCTIONS		
REQUIREMENT	DESCRIPTION	SPECIFICATION

FUNCTIONAL OUTPUTS				
LOC	NAME	STANDARD	TO	LOC

EQUIPMENT TYPES	
o	o
o	o
o	o
o	o
o	o
o	o

FIGURE 4-23

CANADIAN AIRSPACE SYSTEM
SYSTEM DESIGN
LEVEL ONE

SEPTEMBER 1985

4.3.4.9 Visual Approach Slope Indicator (VASI) System

PURPOSE

The Visual Approach Slope Indicator (VASI) System will provide the pilot with visual information for a non-precision approach by presenting a definite white and red light projection along the desired descent path to the touchdown point.

FUNCTION

The VASI system will consist of light fixture units containing lamps and filters and a constant current power supply. The light units will be arranged in bars called the upwind and downwind bars for a two-bar system and upwind, middle, and downwind bars in a three-bar system. In each case, the downwind bar will be the one closest to the runway threshold and the upwind bar will be the farthest from the threshold.

The light units in each bar will be located on a line perpendicular to the runway centerline. Each light unit will project a split beam of light, the upper segment being white and the lower segment red. The transition from red to white or vice versa will occur over a vertical angle of approximately one-quarter degree, with the light in this area being pinkish in colour. When on the proper glide slope in a two-bar system, the downwind bar will appear white and the upwind bar will appear red; if the approach is too low, both bars will be seen as red. The primary function of the VASI will be to provide the pilot visual descent guidance during a non-precision approach to the runway.

Lighting control will be available both from the Control Tower or Flight Service Station and, if the airport is unmanned, via VHF radio from an aircraft.

INTERFACES

Visual Approach Slope Indicator (VASI)/Control Tower/Flight Service Station. This interface will provide the air traffic controller and flight service specialist with operational control of the VASI which, in this case, will be limited to on/off control and intensity control. Operational information concerning on/off status, intensity level or any system or lamp failure condition will be available to the Control Tower and Flight Service Station through the Control and Performance Monitoring System (CPMS).

Visual Approach Slope Indication (VASI)/Control and Performance Monitoring System (CPMS). The VASI will have a Remote Monitoring System (RMS) which will monitor such things as current, voltage, tilt angle, and on/off status. The interface with the VASI RMS will normally be with the Area Maintenance Centre. In addition to providing equipment status and alarm information for maintenance purposes, operational status of the Vasis will be determined and provided to the Control Tower and Flight Service Station. Should the airport be unmanned and control be transferred to the ACC, operational status information will be provided to the ACC via the CPMS and computer center while operational control will be given directly to the pilot through the use of the aircraft's VHF transceiver.

Visual Approach Slope Indicatior/Pilot. This interface will be a visual only and provide the pilot with glide slope information necessary to assist in the approach and landing phases of operation.

Visual Approach Slope Indicator (VASI)/VHF Transceiver. In the event an airport is unmanned, a capability will exist for the pilot to control the on/off status of the VASI via the VHF transceiver in the aircraft. This will be accomplished by tuning the transceiver to the specified VHF frequency and keying the microphone the required number of times within a 5-second interval in accordance with specified procedures. These transmitter pulses or clicks will be received by a VHF radio control unit within the VASI where they will be decoded and utilized to energize relays. These relays control the lighting system and remain energized for a period of 15 minutes from the most recent activation unless subsequent pulses are received to change the activation relays.

VISUAL APPROACH SLOPE INDICATOR (VASI)

FUNCTIONAL INPUTS				
FROM	LOC	NAME	STANDARD	LOC
TWR		Request	TESP	
FSS		Request	TESP	
AMTCECTR		Request	TESP	
TWR		Command	TP312E	
FSS		Command	TP312E	
AIRCRAFT		Command	TP312E	

FACILITY PRINCIPAL FUNCTIONS		
REQUIREMENT	DESCRIPTION	SPECIFICATION
	Provide the pilot with visual descent guidance during an approach	
	Maintenance monitoring	

FUNCTIONAL OUTPUTS				
LOC	NAME	STANDARD	TO	LOC
	Status	TESP	TWR	
	Status	TESP	FSS	
	Status	TESP	AMTCECTR	
	Mntnc Data	TESP	AMTCECTR	
	Visual Gd	TP312E	AIRCRAFT	

EQUIPMENT TYPES	
o	o
o	o
o	o
o	o
o	o
o	o

FIGURE 4-24

4.3.4.10 Precision Approach Path Indicator (PAPI) System

PURPOSE

The Precision Approach Path Indicator (PAPI) System is another of a series of approach slope indicators and will provide the pilot with visual information for non-precision approach by presenting a definite white and red light projection along the desired descent path to the touchdown point.

FUNCTION

The Precision Approach Path Indicator (PAPI) System system will consist of light fixture units, similar to the Visual Approach Slope Indicator (VASI) Systems, containing lamps and filters and a constant current power supply. Each light unit will contain three lamps. Four light units will be arranged in the front of a bar perpendicular to and on the left side of the runway and facing the approach end of the runway. Each unit will be set at a slightly different angle (20 minutes apart) and will emit a beam of high-intensity light, the upper half showing white and the lower half showing red. As seen by the approaching pilot, it will consist of a bar of four quick transition red/white light units whose on-glidepath signal (usually 3 degrees) is two red and two white lights. When the aircraft is slightly below glidepath (between 2 degrees, 50 minutes and 2 degrees, 30 minutes) the signal will change to three red and one white light. When the aircraft is further below the glidepath (below 2 degrees, 30 minutes) a fly-up signal of four red lights will be seen. Conversely, deviations above the glidepath will cause the red light units to turn successively white.

The primary function of the PAPI will be to provide the pilot visual descent guidance during a non-precision approach to the runway.

Lighting control will be available both from the Control Tower or Flight Service Station and, if the airport is unmanned, via VHF radio from an aircraft.

INTERFACES

Precision Approach Path Indicator (PAPI)/Control Tower/Flight Service Station. This interface will provide the air traffic controller and flight service specialist with operational control of the PAPI; i.e., on/off and intensity control. Operational information related to on/off status, intensity level, or any system or lamp failure condition will be available to the Control Tower and Flight Service Station through the Control and Performance Monitoring System (CPMS).

Precision Approach Path Indicator (PAPI)/Control and Performance Monitoring System (CPMS). The PAPI will have a Remote Monitoring System (RMS) which will monitor such things as current, voltage, tilt angle, and on/off status. The interface with the PAPI RMS will normally be with the Area Maintenance Centre. In addition to providing equipment status and alarm information for maintenance purposes, operational status of the PAPI will be determined and provided to the Control Tower and Flight Service Station. Should the airport be unmanned and control be transferred to the ACC, operational status information will be provided to the ACC via the CPMS and computer center while operational control will be given directly to the pilot through the use of the aircraft's VHF transceiver.

Precision Approach Path Indicator (PAPI)/Pilot. This interface will be visual only and provide the pilot with glide slope information necessary to assist in the approach and landing phases of operation.

Precision Approach Path Indicator (PAPI)/VHF Transceiver. In the event an airport is unmanned, a capability will exist for the pilot to control the on/off status of the PAPI via the VHF transceiver in the aircraft. This will be accomplished by tuning the transceiver to the specified VHF frequency and keying the microphone the required number of times within a 5-second interval in accordance with specified procedures. These transmitter pulses or clicks will be received by a VHF radio control unit within the PAPI where they will be decoded and utilized to energize relays. These relays control the lighting system and remain energized for a period of 15 minutes from the most recent activation unless subsequent pulses are received to change the activation relays.

PRECISION APPROACH PATH INDICATOR (PAPI)

FUNCTIONAL INPUTS				
FROM	LOC	NAME	STANDARD	LOC
TWR		Request	TESP	
FSS		Request	TESP	
AMTCECTR		Request	TESP	
TWR		Command	TP312E	
FSS		Command	TP312E	
AIRCRAFT		Command	TP312E	

FACILITY PRINCIPAL FUNCTIONS		
REQUIREMENT	DESCRIPTION	SPECIFICATION
	Provide the pilot with visual descent guidance during an approach	
	Maintenance monitoring	

FUNCTIONAL OUTPUTS				
LOC	NAME	STANDARD	TO	LOC
	Status	TESP	TWR	
	Status	TESP	FSS	
	Status	TESP	AMTCECTR	
	Mntnc Data	TESP	AMTCECTR	
	Visual Gd	TP312E	AIRCRAFT	

EQUIPMENT TYPES	
o	o
o	o
o	o
o	o
o	o
o	o

FIGURE 4-25

CANADIAN AIRSPACE SYSTEM
SYSTEM DESIGN
LEVEL ONE

SEPTEMBER 1985

4.3.4.11 Pulse Light Approach Slope Indicator (PLASI) System

PURPOSE

The Pulse Light Approach Slope Indicator (PLASI) System is another in a series of approach slope indicators and will provide the pilot with visual information for a non-precision approach by presenting a continuous white light projection along the desired descent path to the touchdown point.

FUNCTION

The PLASI system will consist of a single light unit containing a single tungsten halogen lamp, a condenser lens, a movable shutter, and a red filter. It will also contain a sensor and changer motor which performs automatic lamp changing should a lamp fail.

The single light unit will be installed next to the runway near the intended touchdown point. From the pilots point of view, when on the glidepath, a continuous burning white light will be seen. When above the glidepath, a pulsing or flashing white light will be seen; and when below the glidepath, a pulsing red light will be seen. The pulses of white and red "above" and "below" lights will vary in length from continuous at the edge of the glidepath to zero pulse length at the "off glidepath" limit of visual contact. This variation in light pulse length, long near the path, shorter and shorter as deviation from the glidepath increases, will provide the pilot quantitative deviation information.

The primary function of the PLASI will be to provide the pilot visual descent guidance during a non-precision approach to the runway.

Lighting control will be available both from the Control Tower or Flight Service Station and, if the airport is unmanned, via VHF radio from an aircraft.

INTERFACES

Pulse Light Approach Slope Indicator (PLASI)/Control Tower/Flight Service Station. This interface will provide the air traffic controller and flight service specialist with operational control of the PLASI; i.e., on/off and intensity control. Operational information related to on/off status, intensity level, or any system or lamp failure condition will be available to the TWR and FSS through the Control and Performance Monitoring System (CPMS).

Pulse Light Approach Slope Indicator (PLASI)/Control and Performance Monitoring System (CPMS). The PLASI will have a Remote Monitoring System (RMS) which will monitor such things as current, voltage, tilt angle, and on/off status. The interface with the PLASI RMS will normally be with the Area Maintenance Centre. In addition to providing equipment status and alarm information for maintenance purposes, operational status of the PLASI will be determined and provided to the TWR and FSS. Should the airport be unmanned and control be transferred to the ACC, operational status information will be provided to the ACC via the CPMS and computer center while operational control will be given directly to the pilot through the use of the aircraft's VHF transceiver.

Pulse Light Approach Slope Indicator (PLASI)/Pilot. This interface will be visual only and provide the pilot with a glide slope information necessary to assist in an approach and landing operation.

Pulse Light Approach Slope Indicator (PLASI)/VHF Transceiver. In the event an airport is unmanned, a capability will exist for the pilot to control the on/off status of the PLASI via the VHF transceiver in the aircraft. This will be accomplished by tuning the transceiver to the specified VHF frequency and keying the microphone the required number of times within a 5-second interval in accordance with specified procedures. These transmitter pulses or clicks will be received by a VHF radio control unit within the PLASI where they will be decoded and utilized to energize relays. These relays control the lighting system and remain energized for a period of 15 minutes from the most recent activation unless subsequent pulses are received to change the activation relays.

PULSE LIGHT APPROACH SLOPE INDICATOR (PLASI)

FUNCTIONAL INPUTS				
FROM	LOC	NAME	STANDARD	LOC
TWR		Request	TESP	
FSS		Request	TESP	
AMTCECTR		Request	TESP	
TWR		Command	TP312E	
FSS		Command	TP312E	
AIRCRAFT		Command	TP312E	

FACILITY PRINCIPAL FUNCTIONS		
REQUIREMENT	DESCRIPTION	SPECIFICATION
	Provide the pilot with visual descent guidance during an approach	
	Maintenance monitoring	

FUNCTIONAL OUTPUTS				
LOC	NAME	STANDARD	TO	LOC
	Status	TESP	TWR	
	Status	TESP	FSS	
	Status	TESP	AMTCECTR	
	Mntnc Data	TESP	AMTCECTR	
	Visual Gd	TP312E	AIRCRAFT	

EQUIPMENT TYPES	
o	o
o	o
o	o
o	o
o	o
o	o

FIGURE 4-26

CANADIAN AIRSPACE SYSTEM
SYSTEM DESIGN
LEVEL ONE

SEPTEMBER 1985

4.3.4.12 Runway Visual Range (RVR) System

PURPOSE

The Runway Visual Range (RVR) System is in the Canadian Airspace System today and will continue to be a part of the system described in this document. The RVR is derived from information provided by a transmissometer located near the runway. RVR is a computed visability value that represents the maximum distance a pilot should be able to see along the runway, based on his sighting of the runway, runway markers, or runway lights (at particular settings). This information will be forwarded to pilots during periods of reduced visibility to enhance the safe operation of aircraft arriving and departing the airport. It will also be used to help determine the minimum approach category operating conditions.

FUNCTION

The RVR system will be associated with Instrument Landing Systems (ILS) or Microwave Landing Systems (MLS). It will measure airfield restrictions to visibility (fog, snow, rain), as required, at the touchdown, midpoint, and rollout points of the instrument runway. Receiver signal output representing atomospheric transmittance will be transmitted to an RVR computer for processing into an RVR value.

The RVR computer will use the degree of atmospheric transmittance along with simultaneous indications of runway light intensity setting and background luminance (day-or-night) class of ambient illumination to solve visibility equations.

A supporting function of the RVR will be to monitor various maintenance and performance parameters and respond to maintenance control commands in support of the Control and Performance Monitoring System (CPMS).

INTERFACES

Runway Visual Range (RVR)/Control Tower/Flight Service Station. The Air Traffic Service (ATS) controller or specialist will select runway light intensity settings, which are fed to the RVR computer for use in the visibility equations. The RVR values, in hundreds of feet, will be transmitted to ATS for display.

Runway Visual Range (RVR)/Control and Performance Monitoring System (CPMS). The RVR will have built-in Remote Maintenance Monitoring capabilities including an interface with the rest of the CPMS. The interface will generally be with the RMC. This interface will be a common-type interface for all remote facilities.

RUNWAY VISUAL RANGE (RVR)

FUNCTIONAL INPUTS				
FROM	LOC	NAME	STANDARD	LOC
THR		Request	TESP	
FSS		Request	TESP	
AMTCECTR		Request	TESP	
THR		Command	TP312E	
FSS		Command	TP312E	
AMTCECTR		Command	TP312E	
AMTCECTR		Command	4-3TRAMS	
AMTCECTR		Command	4-3MONCO	

FACILITY PRINCIPAL FUNCTIONS		
REQUIREMENT	DESCRIPTION	SPECIFICATION
	Measures horizontal visibility	
	Maintenance monitoring	

FUNCTIONAL OUTPUTS				
LOC	NAME	STANDARD	TO	LOC
	Rwy Vis	4-3MONCO	THR	
	Rwy Vis	4-3MONCO	FSS	
	Rwy Vis	ICAO 10	MLS	
	Rwy Vis	ICAO 10	AMTCECTR	
	Status	4-3MONCO	AMTCECTR	
	Status	4-3TRAMS	AMTCECTR	

EQUIPMENT TYPES	
o PEP 8303	o
o CVD 8404	o
o	o
o	o
o	o
o	o

FIGURE 4-27

CANADIAN AIRSPACE SYSTEM
SYSTEM DESIGN
LEVEL ONE

SEPTEMBER 1985

4.3.4.13 Instrument Landing System (ILS)

PURPOSE

The Instrument Landing System (ILS) is an electronic navigational aid used to provide approach and landing guidance to the pilot during approaches to Instrument Flight Rules (IFR) runways.

FUNCTION

The ILS provides a single fixed approach path to a runway for suitably equipped aircraft by means of a localizer, glidepath, and marker system. The localizer, operating in the 108-112 MHz frequency band, provides azimuth information by means of 90 and 150 Hz amplitude modulation of the carrier. The glidepath, operating in the 328-335 MHz band, similarly provides elevation information. The outer and middle markers, operating in the 75 MHz band, provides single point distance fixes to the pilot. A back beam marker may also be provided to allow non-precision approaches on the reciprocal runway. Distance Measuring Equipment (DME) operating in the 960-1215 MHz band, or Precision Distance Measuring Equipment (DME/P), may optionally be used in place of markers at some installations.

INTERFACES

Instrument Landing System (ILS)/ILS Receiver. The ILS localizer and glidepath transmitter will interface with the appropriate VHF and UHF receiver in the aircraft for VHF and UHF radio signals.

Instrument Landing System (ILS)/Marker Beacon Receiver. The marker beacons will interface with the 75MHz marker beacon receiver in the aircraft.

Instrument Landing System (ILS)/Precision Distance Measuring Equipment (DME/P). The interface exists only where a DME is co-located with an ILS. The ILS exchanges timing information with DME for synchronizing and interleaving the facility identification broadcast.

Instrument Landing System Distance Measuring Equipment/Distance Measuring Equipment Receiver (Optional). See DME description in Navigation Section.

Instrument Landing System (ILS)/Control and Performance Monitoring System (CPMS). The ILS elements will have a remote monitoring subsystem (RMS) that will normally interface with a Regional Maintenance Centre (RMC). The ILS will receive operational control signals from the Control Tower or Flight Service Station and send operational status to the Control Tower or Flight Service Station through the CPMS. The RMS will monitor glide path and localizer parameters such as alignment, width, and RF power. The RMS will also monitor suitable marker parameters and where DME or DME/P is installed, control and monitoring facilities will be provided.

INSTRUMENT LANDING SYSTEM (ILS)

FUNCTIONAL INPUTS				
FROM	LOC	NAME	STANDARD	LOC
TWR		Request		
FSS		Request		
AMTCECTR		Request		
TWR		Command		
FSS		Command		
AMTCECTR		Command		

FACILITY PRINCIPAL FUNCTIONS		
REQUIREMENT	DESCRIPTION	SPECIFICATION
	Provide the pilot with azimuth guidance to the runway centerline	
	Provide the pilot with glidepath descent angle to touchdown	
	Provide the pilot with discrete distance information (MKR) or continuous distance information (DME/N - optional)	
	Provide the pilot with back course guidance to runway centerline (only for non-precision approaches)	

FUNCTIONAL OUTPUTS				
LOC	NAME	STANDARD	TO	LOC
	AzGuidance	A-10	AIRCRAFT	
	Glide Path	A-10	AIRCRAFT	
	Distance	A-10	AIRCRAFT	
	BackCourse	A-10	AIRCRAFT	
	Fac Ident	A-10	AIRCRAFT	
	Status		TWR	
	Status		FSS	
	Status		AMTCECTR	

EQUIPMENT TYPES	
o PHL 7301	o
o PHL 7002	o
o PHL 7404	o
o DME/N - RYC 7005, 7502	o
o 7704, 8102	o
o	o

FIGURE 4-28

4.3.4.14 Microwave Landing System (MLS)

PURPOSE

The Microwave Landing System (MLS) is an electronic approach and landing aid to pilots making instrument approaches to certain airports.

FUNCTION

The MLS will provide precision azimuth (AZ), elevation (EL), and precision distance (DME/P) information to the pilot. The angle equipment (AZ and EL) will operate on one of 200 frequencies (channels) between 5031 and 5091 MHz inclusive. The azimuth subsystem will provide a minimum of plus-or-minus ten degrees of proportional coverage (a maximum of plus-or-minus 60 degrees is possible) and clearances to at least plus-or-minus 40 degrees.

The elevation subsystem will provide pilot selectable glidepath angles of up to at least 15 degrees. Because of the increased proportional coverage volume available over the single approach path offered by the ILS, it will be possible to create multiple or special approaches to any one facility to satisfy diverse operational considerations.

The distance information will be provided by the precision DME (DME/P) transponder which operates in the L-Band an functions in two modes: Initial approach (IA) mode, and final approach (FA) mode. The IA mode is designed to support the intial stages of approach, while the FA mode provides the improved accuracy of plus-or-minus 30 metres for operation in the final approach area. The DME/P IA mode is fully compatible and interoperable with the conventional enroute DME/N, but the accuracy is limited to that of the DME/N system (air or ground).

All MLS installations will transmit basic data consisting of distance, proportional coverage limits, back azimuth status, and azimuth orientation relative to compass bearing, to allow the airborne receiver to process the scanning beam information for various ground equipment configurations so that they are meaningful to the pilot or airborne system. Provision for additional data describing the relative placements of ground equipment, approach and missed approach paths and procedures, and meteorological and operational data used for special interest applications will also be made.

INTERFACES

Microwave Landing System (MLS)/MLS Receiver. The airborne MLS receiver will, when tuned to the appropriate MLS channel, receive the swept azimuth and elevation beams, and with the data contained in the transmitted data, will be able to convert the received signals into azimuth and elevation guidance information which will be presented to the pilot on his course deviation indicator, horizontal situation indicator, or electronic flight display such as a cathode ray tube.

Microwave Landing System (MLS)/Precision Distance Measuring Equipment (DME-P) Interrogator. The airborne equipment interrogates a ground transponder with paired pulses of a specific shape and spacing. The ground system, after a predetermined delay, transmits a reply consisting of paired pulses on a different frequency. The airborne equipment measures the time difference between the transmitted and received signals and computes the range.

If the MLS receiver and the DME/P receiver are both interfaced with an Area Navigation (RNAV) computer, a capability for computed offsets, segmented and curved approaches could be provided.

Microwave Landing System (MLS)/Control and Performance Monitoring System (CPMS)/Control Tower/Flight Service Station. The MLS elements will have a remote monitoring subsystem that will interface with the Control and Performance Monitoring System (CPMS). The MLS will receive operational control signals from the Tower or FSS and send operational status to the Tower or FSS. Should the airport be unmanned, and control transferred to the ACC, the same capability will be provided to the controlling ACC through the CPMS. The CPMS will also monitor such things as equipment performance, operational status, environmental conditions, and security status.

MICROWAVE LANDING SYSTEM (MLS)

FUNCTIONAL INPUTS				
FROM	LOC	NAME	STANDARD	LOC
TWR		Request	TESP	
FSS		Request	TESP	
AMTCECTR		Request	TESP	
TWR		Command	TESP	
FSS		Command	TESP	
AMTCECTR		Command	TESP	
RVR COMP		Request	TESP	
LCL TERM		Request	TESP	
AWORS		Request	TESP	

FACILITY PRINCIPAL FUNCTIONS		
REQUIREMENT	DESCRIPTION	SPECIFICATION
	Provide pilot selectable azimuth guidance to runway centerline	
	Provide pilot selectable glidepath descent angle to touchdown	
	Provide continuous distance information for approach	
	Provide optional back azimuth guidance for missed approach procedures	
	NOTE: With properly equipped avionics, guidance for offset, augmented and curved approaches can be provided	

FUNCTIONAL OUTPUTS				
LOC	NAME	STANDARD	TO	LOC
	Azimuth Gd	ICAO 10	AIRCRAFT	
	Elev Guide	ICAO 10	AIRCRAFT	
	Dist Guide	ICAO 10	AIRCRAFT	
	Back AZ Gd	ICAO 10	AIRCRAFT	
	FacilityID	ICAO 10	AIRCRAFT	
	Site Data	ICAO 10	AIRCRAFT	
	Status	TESP	TWR	
	Status	TESP	FSS	
	Status	TESP	AMTCECTR	

EQUIPMENT TYPES

- MLS
- AZ XXX
- EL XXXX
- DME/P XXX
- BAZ XXXX

FIGURE 4-29

4.3.5 VERY HIGH FREQUENCY OMNI-RANGE TEST FACILITY (VOT)

PURPOSE

The Very High Frequency Omni-Range Test (VOT) system is a ground based low power navigational aid which provides a means for pilots to perform VOR receiver checks. It is used independently of the VOR system at airports where a VOR signal checkpoint cannot be established. The VOT signal will be used by the pilot to perform VOR receiver accuracy checks prior to takeoff.

FUNCTION

The primary function of the VOT is to provide a test signal to perform VOR airborne receiver accuracy checks. This is provided by means of the carrier which is radiated in the 108-118 MHz band and modulated by two signals in such a way that their phases are independent of azimuth and coincide with each other at all times. When tuned to the VOT station frequency, the VOR receiver will indicate zero degrees irrespective of the aircraft's angular position to the VOT if the receiver is working properly.

At some airports without a VOT, but within ground receiption range of a VOR, a pilot will be able to perform receiver checks by using that VOR at fixed points on the airport that have been certified for that purpose.

VERY HIGH FREQUENCY OMNI-RANGE TEST FACILITY (VOT)

FUNCTIONAL INPUTS				
FROM	LOC	NAME	STANDARD	LOC

FACILITY PRINCIPAL FUNCTIONS		
REQUIREMENT	DESCRIPTION	SPECIFICATION
	Aircraft VOR Receiver Test	

FUNCTIONAL OUTPUTS				
LOC	NAME	STANDARD	TO	LOC
	VOR TstSig		AIRCRAFT	

EQUIPMENT TYPES	
o PHL 7606	o
o FRN 1012	o
o	o
o	o
o	o
o	o

FIGURE 4-30

CANADIAN AIRSPACE SYSTEM
SYSTEM DESIGN
LEVEL ONE

SEPTEMBER 1985

4.3.5.1 Very High Frequency Omni-Range Test (VOT)

The VOT system is a single-channel transmitter system with a single monitor. It is designed primarily for location at an airport facility or where aircraft VOR systems are tested. Aurally, the VOT is identified by a continuous series of dots and, in many cases, supplemented by voice recording. The monitor checks that the transmitted information is correct with respect to its bearing content, level of modulating signals, and identification code.

The VOT radiates a standard VOR test signal of equal strength omni-directionally. Regardless of the angular position of an aircraft receiver within the coverage area, when it is tuned to the VOT station frequency, it receives zero degrees `FROM' course information similar to the indication which would be received when heading North from a VOR station.

The VHF carrier signal that is radiated from a VOT station contains the following components:

(a) Azimuth information

(b) Station identification

(c) Speech (optional)

4.3.5.1.1 Azimuth Information

Operation of the VOT is based on transmitting a signal equivalent to that transmitted from the VOR facility along its zero degree (i.e., normally magnetic North) radial.

As in the VOR, a VHF carrier is modulated simultaneously with a 30Hz signal (variable phase signal), a 9960Hz f-m subcarrier signal, an on-off keyed 1020Hz identification signal, and a voice signal. The subcarrier signal is frequency modulated by a 30Hz signal (reference phase signal). In VOR, the phase difference between the two 30Hz signals varies degree for degree with the azimuth bearing of the receiving point, magnetic North normally being the reference datum where the two signals are in phase. In VOT, the phases of the two 30Hz signals are coincident at all times giving a zero degrees `FROM' indication irrespective of the azimuth bearing of the receiving point. This in-phase condition is obtained when the maximum value of the r f carrier due to the variable phase signal amplitude modulation (i.e., at the highest peak of the 30Hz variable) occurs at the same time as the highest instantaneous frequency of the subcarrier.

4.3.5.1.2 Station Identification

Station identification nomenclature is provided by a keyed 1020Hz signal. This identification is a continuous sequence of single dots. The nominal pulse width is 125ms; the pulse repetition rate is 4Hz. There is a strapping option which gives either identification interrupted during voice transmission or identification uninterrupted during voice transmission.

4.2.5.1.3 Speech Channel Facilities

Speech facilities are provided by the transmitter in the 300Hz to 3kHz bandwidth. The transmission of speech is initiated by closure of remote press-to-talk contacts and transmission of a voice signal over a 600 ohm landline at a level between 0 and -20dBm.

4.3.5.1.4 VOT Transmission

The VOT signal is transmitted omni-directionally by a specially designed antenna. The antenna is an Alford loop formed by printed circuit techniques, mounted horizontally on a pedestal. the loop orientation is irrelevant.

The test station transmits on a carrier frequency in the range 108 to 118MHZ, each station being allotted a specific frequency which is maintained by a crystal-controlled oscillator.

The signal consists of a VHF modulated with a composite audio signal. As described in paragraph 4.3.5.1.1, the composite audio signal includes the reference phase signal and the variable phase signal, both in normal VOR format. The two signals are combined in the relationship of the North zero degree bearing.

INTERFACES

VOT/FSS/REMOTE DATA BANK. As indicated in paragraph 4.3.5.1.3 the VOT signal can be made to contain speech data such as terminal information (ATIS) or weather data. This voice data can be optionally provided remotely from the local Flight Service Station or from a remote data bank.

4.3.6 VERY HIGH FREQUENCY OMNI-RANGE (VOR)/DISTANCE MEASURING EQUIPMENT (DME)/TACTICAL AIR NAVIGATION (TACAN)

PURPOSE

The VOR/DME and VOR/TAC will continue to be part of the navigational aid network to establish the Canadian airway structure. They are also capable of supporting the use of Area Navigation techniques.

Through the VOR, a voice communications link to the pilot will be provided either for emergency communications or for transmission of aeronautical and meteorological information. The DME and TACAN are functionally identical to the civil air users. They are used to provide the pilot with a means of measuring the distance (slant range) between the aircraft and the geographic fix at which the DME or TACAN is located.

The DME/TACAN will be used by aircraft so equipped to update their onboard inertial navigation equipment in support of Area Navigation techniques.

FUNCTION

The primary function of the VOR/DME and VOR/TAC is to provide airway guidance to the pilots. The VOR performs this function by continuously transmitting an azimuth reference signal from which an aircraft can determine its bearing. This is achieved by the carrier radiated in the 108-118MHz band and modulated by two 30Hz signals, one FM and one AM, in such a way that their phase difference varies, in degrees, with the magnetic bearing around the VOR. In conjunction with the DME (or DME portion of the TACAN) colocated with the VOR, a reference vector (i.e., distance and bearing information) is available to the pilot.

The DME/TACAN provides the distance function. This is achieved by receiving and demodulating a set of paired pulses which are periodically sent by the aircraft avionics to interrogate the ground based DME. The air-to-ground interrogation and replies generated by the ground station occurs within the band from 962-1213MHz and are displaced from each other by 63MHz. The interrogation and reply frequencies are assigned with a one MegaHertz spacing between channels. Pulse coding is used to effectively double the number of interrogation channels available for use in the airborne interrogator.

The function of the airborne DME is to measure the distance from a ground transponder. The airborne interrogator-receiver transmits a continuous train of pulse pairs through an omni-directional antenna. The interrogation signal is picked up by the receiver of the ground transponder. This signal is checked for the proper frequency and puse spacing; if these are acceptable, the transponder replies with a pair of consecutive RF pulses at a frequency 63MHz above or below the received signal and with a fixed pulse spacing. The reply is checked for proper separation by the decoder in the aircraft. If the pulse spacing is correct, the time delay between the second interrogation pulse and the second reply pulse is measured. The time delay is translated into a distance measurement and presented on a display in the cockpit of the aircraft.

VERY HIGH FREQUENCY OMNI-RANGE (VOR)/DISTANCE MEASURING EQUIPMENT (DME)/TACTICAL AIR NAVIGATION (TACAN)

FUNCTIONAL INPUTS				
FROM	LOC	NAME	STANDARD	LOC
FSS AVWXCTR AWORS FSS RMTCECTR		Ops Ctl Wx Data Wx Data Emgcy Comm Equip Ctl		

FACILITY PRINCIPAL FUNCTIONS		
REQUIREMENT	DESCRIPTION	SPECIFICATION
	Airways Guidance (Civil and Military)	
	Broadcast/Emergency Communications Link	
	Non-Precision Approach	
	Weather Broadcast	
	Distance measuring	
	Maintenance monitoring BITE	
	Executive Monitoring	

FUNCTIONAL OUTPUTS				
LOC	NAME	STANDARD	TO	LOC
	Equip Stat Ops Status		RMTCECTR FSS	

EQUIPMENT TYPES

- VOR - RYC 7004, CHCM122320, FRN 1007, CAE 10303, PHL 7503, PHL 7504, PHL 8303, PHL 8304
- TACAN - GRN 501,502
- DME - RYC 7001, 7502, 7704, 8102, 8401
- VOR Executive Monitor
- DME BITE
- CPMS Interface Unit
- Test Instruments

FIGURE 4-31

4.3.6.1 Very High Frequency Omni-Range (VOR)

The VOR system is a dual-channel transmitter system with parallel monitoring facilities. It is a navigational aid which can be located at the terminal or enroute facility. Aurally, the VOR is identified by a three-letter coding and, in many cases, can be supplemented by voice recording. The VOR will be co-located with DME to give distance measuring capability in addition to bearing data.

The VOR concept is based on the 360 degree radials which originate from a transmitting station and on the airborne equipment which resolves the particular radial from the station which passes through the aircraft position. This resolved radial is the displacement angle between magnetic north and the aircraft as measured from the VOR antenna. Therefore, regardless of its heading, an aircraft which is on the 90 degree radial, is due east of the VOR station. The magnetic course to the station is the reciprocal of the radial determined by the aircraft.

The SVOR (Standard VOR) and DVOR (Doppler VOR) are functionally identical.

The VHF carrier signal that is radiated from a VOR station contains the following components:

(a) Azimuth information

(b) Station identification

(c) Speech (optional)

4.3.6.1.1 Azimuth Information

Operation of the VOR is based on the phase difference between two 30Hz signals modulated on the carrier: a reference phase and a variable phase.

4.3.6.1.1.1 Standard VOR (SVOR)

The reference phase signal is obtained by amplitude modulating the carrier with a subcarrier of 9960Hz centre frequency which is, in turn, frequency modulated with a 30Hz sine wave signal with a nominal deviation of plus-or-minus 480Hz. This amplitude modulated signal is radiated omnidirectionally in the horizontal plane by the antenna, the radiation pattern being a circle. In the aircraft receiver it produces a 30Hz signal the phase of which is independent of the azimuth and is therefore called the reference phase signal.

The variable phase signal in an SVOR is obtained by rotating at 1800 RPM (30Hz) an antenna radiation pattern which in the horizontal plane has a shape of a limacon. This pattern is produced by adding in space the omnidirectionally -radiated carrier and a rotating figure-of-eight pattern. The signal received by the receiver is therefore amplitude modulated with a 30Hz sine wave signal, the phase of which varies linearly with the change of the azimuth bearing in which it is radiated, i.e., for each degree of the azimuth change, the phase of the 30Hz variable phase signal changes by one degree.

4.3.6.1.1.2 Doppler VOR (DVOR)

The reference phase signal is obtained by amplitude modulating the carrier with a 30Hz sine-wave signal. This amplitude modulated signal is radiated omnidirectionally in the horizontal plane by the central, carrier antenna (the radiation patter is a circle) and produces in the aircraft receiver a 30Hz signal the phase of which is independent of azimuth and is therefore called the reference phase signal.

The variable phase signal is obtained from the 9960Hz frequency modulated subcarrier which amplitude modulates the carrier. This amplitude modulation of the carrier is often referred to as the space modulation since it is obtained by adding in space the omnidirectionally radiated carrier and the upper (SB1) and the lower (SB2) sideband signals radiated from the ring of 48 sideband antennas. The sideband signals are displaced on average 9960Hz above and below the carrier and, when added in correct phase to the carrier will produce a signal amplitude modulated at 9960Hz.

4.3.6.1.2 Station Identification

Station identification nomenclature in both types of VOR's are provided by a 1020Hz signal in Morse code. This identification is generated by the VOR and one of every fourth identification groups is used to key the DME at 1350Hz.

4.3.6.1.3 Speech Channel Facilities

Speech is transmitted by the reference phase transmitter in the 300Hz to 3kHz bandwidth. Meterological data is normally transmitted, but in emergencies the speech channel can be used for communication with the aircraft.

INTERFACES

Very High Frequency Omni Range (VOR)/Distance Measuring Equipment (DME)/Tactical Air Navigation (TACAN). The VOR generates the identification signal for itself and the colocated DME or the DME portion of the TACAN. In the event of VOR failure the DME/TACAN provides its own identification signal.

Very High Frequency Omni Range (VOR)/Automated Weather Observation and Reporting System (AWORS)/Automated Terminal Information System (ATIS)/Flight Service Station. The speech broadcast will be obtained via normal telephone lines either from a local Automatic Weather Observation and Reporting Station (AWORS) or from a remotely generated ATIS message or weather message centre. In an emergency situation the ground ATS specialist will use this speech capability to communicate with any aircraft within the VOR broadcast range.

Very High Frequency Omni Range (VOR)/Control and Performance Monitoring System (CPMS). The VOR will be interfaced to a remote maintenance centre through a local interface panel and auto-dial unit using normal switched telephone circuits. In the event of a failure of any part of the VOR an alarm will be also sent to the operational control centre for the purpose of issuing a NOTAM either directly or through the Control and Performance Monitoring System (CPMS).

Very High Frequency Omni Range (VOR)/Backup Power. In the event of a commercial power failure, emergency power is obtained from a local (site installed) diesel generator (IPU)

4.3.6.2 Distance Measuring Equipment (DME)

DME is an active system providing the aircraft with range information. A DME transponder is installed on the ground in order to detect and decode the interrogations received from the aircraft and to encode and generate an appropriate reply for transmission back to the aircraft. The air-to-ground interrogations and the replies generated by the ground station occur within the band from 962 to 1213Mhz and are displaced from each other by 63MHZ. The interrogation and reply frequencies are assigned with a one megahertz spacing between channels. Pulse coding is used to effectively double the number of interrogation channels available for use in the airborne interrogator.

The function of the airborne DME is to measure the distance from a ground transponder. The airborne interrogator-receiver transmits a continuous train of pulse pairs through an omnidirectinal antenna. the interrogation signal is picked up by the receiver of the ground transponder. This signal is checked for the proper frequency and puse spacing; if these are acceptable, the transponder replies with a pair of consecutive RF pulses at a frequency of 63MHz above or below the received signal and with a fixed pulse spacing. The reply is checked for proper separation by the decoder in the aircraft. If the pulse spacing is correct, the time delay between the second interrogation pulse and the second reply pulse is measured. The time delay is translated into a distance measurement and presented on a display in the cockpit of the aircraft.

The system is continuously monitored by a dual montoring system. Each Monitor Unit contains an Interrogation Signal Generator (ISG) which simulates the interrogation of one aircraft locked on to the station. The ISG pulses are mixed with the local oscillator frequency to produce a receiver signal which is applied to the Diplexers via the Antenna Transfer Switch. The ISG pulses are processed and then reapplied to the Diplexer as part of the transmitter output. The Monitor Units monitor the forward and reverse power to detect these replies. Due to the dual monitoring system, both Monitor Units must detect the fault before an alarm is initiated.

One of these two Monitor Units will be removed and replaced by a Built In Test Equipment (BITE) monitor which will have two functions: one is to perform the identical role as the removed Monitor Unit and the second to automatically test the DME system and provide a remote status indication to the operations control centre and to the maintenance centre through the interface panel and local dial-up unit.

4.3.6.2.1 Station Identification

Station identification is produced by the VOR which keys the DME identification such that every fourth identification code is generated and transmitted by the DME at a frequency of 1350Hz. In the event of a DME failure, station identification reverts totally to VOR and the DME identification group is not transmitted.

4.3.6.2.2 Station Identification Signals.

In addition to the distance reply pulses and bearing information pulses, the ground station transmits an audio signal in International Morse Code every 30 seconds which enables the aircraft to identify the station. The signal consists of a train of 2700 pulse pairs per second, generated at a fixed rate of 1350 cps. The aircraft receiver decodes the pulses representing these signals and reproduces them as dots and dashes. The duration of the identity signal dot is 0.1 second, that of the dash, 0.3 second.

INTERFACES

Distance Measuring Equipment (DME)/Tactical Air Navigation (TACAN)/Very High Frequency Omni Range (VOR). The DME and TACAN systems, although completely self contained, are frequency paired with the colocated VOR so that when the pilot selects a particular facility, his receiver takes in both the VOR and the DME/TACAN. The DME/TACAN identification is keyed by the VOR in such a way that every fourth signal is the DME/TACAN one. In the event of a VOR failure, the DME/TACAN then provides its own identification sequence with a break where the VOR identification would normally have been.

Distance Measuring Equipment (DME)/Tactical Air Navigation (TACAN)/Control and Performance Monitoring System (CPMS). The DME/TACAN will be interfaced to the remote maintenance centre through a local interface panel and auto-dial unit using normal switched telephone circuits. In the event of failure of any part of the VOR an alarm will also be sent to the oeprational control centre for the purpose of issuing a NOTAM either directly or through the CPMS.

Distance Measuring Equipment (DME)/Tactical Air Navigation (TACAN)/Backup Power. In the event of a commercial power failure, emergency power will be obtained from a local (site installed) diesel generator unit (IPU).

4.3.6.3 Tactical Air Navigation (TACAN) SYSTEM

The TACAN facility is designed to provide azimuth, identity, and distance information to aircraft provided with proper equipment. Airborne equipment consists of a transmitter-receiver called an interrogator. Ground station components consist of a Ground Beacon an Antenna and Test, Monitor, and Control Units.

The TACAN facility enables an aircraft equipment with the proper interrogation components to determine its geographic position with precision. Because the system operates at high frequency, line-of-sight transmission is required between the aircraft and ground station.

Thus the pilot selects a specific ground station in his area for navigation information. Signals from this station provide the pilot with display indications of the aircraft distance in nautical miles from the station. With distance and bearing established from a specific location the aircraft pilot can fix his position on a chart.

The ground station equipment comprises a radio beacon set, power supplies, an antenna, and control, test, and monitor units. The airborne equipment includes a multi-channel transmitter-receiver group and visual bearing and distance indicators. Essentially, the ground station radio beacon set is a transmitter-receiver combination (transponder) for the receiption and transmission of information used in determining aircraft distance from the ground station. The addition of a rotating directional antenna permits the transmission of bearing information to the aircraft. The antenna, which is common to both functions, receives and transmits all information.

The TACAN system operates in the frequency range of 962 through 1213 MHZ. Each ground station is capable of receiving air-to-ground transmissions on one of the 126 assigned frequencies in the 1025 through 1150 MHz band. The station can transmit on any one of 63 frequencies from 962 through 1024 MHz (low-band installation) or on any one of 63 frequencies from 1151 through 1213 MHz (high-band installation). The receiving frequency of any ground station is 63 MHz above the transmitting frequency in low-band installations and 63 MHz below the transmitting frequency in high-band installations. Adjacent channel frequencies are 1 MHz apart. The antenna of any ground station may be easily modified for operation on either the high or low band.

The ground station output consists of replies to distance interrogations from the aircraft, bearing information signals, station identification signals, and random pulses. Signals from both the ground station and the aircraft are transmitted in the form of coded pairs of 3.5 microsecond wide pulses having a 12 microsecond spacing between the pulses in a pair. This spacing helps the transponder to discriminate against unwanted signals.

4.3.6.3.1 Distance Measurements.

When the aircraft's pilot selects a ground station, the airborne transmitter sends out distance interrogation pulses on the receiving channel frequency assigned to the ground station. These pulses are picked up by the ground station receiver whose output triggers its associated transmitter into sending out reply pulse pairs on its assigned transmitting channel. Radio energy travels at a know and constant speed, so the distance between the aircraft and ground station is determined by the elapsed time between the initial transmission of the interrogation and the reception of the reply from the ground station. There is a 50 microsecond delay between reception of the aircraft's signal and transmission of the reply. Timing circuits on the aircraft measure the time intervals between the interrogation and reply, subtract the 50 microsecond delay, and convert the reply into signal pulses which operate the distance indicator.

A ground station may be interrogated simultaneously by as many as 100 aircraft in its vicinity. Each aircraft queries the selected ground station by transmitting a constant number of pulse pairs per second with nonuniform spacing between pairs. The variation in spacing between pulse pairs is peculiar to each aircraft. Setting up a random pattern for each aircraft precludes one aircraft's locking on the range information replies intended for another.

The aircraft receiver sorts out its own distance reply from transmissions to other aircraft by locating a time-delay period that remains essentially constant between a group of its own interrogation pulses and a series of reply pulses transmitted by the ground station. The aircraft uses an automatic stroboscopic process which sets up a search pattern each time the aircraft is tuned to a new station. The stroboscopic process tests various delay intervals by checking the number of successive replies received within a uniform period. At some particular interval, the repetition rate of the reply matches the repetition rate of the interrogations. The reply pulse pairs are the only ones which have the same spacing between pairs as the random interrogation pulses from the aircraft. When the two kinds of pulses are determined to be synchronous, the airborne receiver locks on the reply pulses and automatically tracks the ground station.

4.3.6.3.2 Bearing Information.

Bearing data originates at the ground station and is multiplexed with the distance-measuring signals. The information received at the aircraft is the compass heading (from magnetic north) from the aircraft to the ground station. The aircraft obtains this bearing by comparing the phase of two modulated frequency components imposed by the antenna on the ground station output with the time occurrence of reference signal bursts transmitted by the beacon.

Since this portion of the TACAN is not used by civil traffic but by military aircraft, no additional details will be provided.

4.3.7 NON-DIRECTIONAL BEACON (NDB)

PURPOSE

The Non-Directional Beacon (NDB) is a low or medium frequency radio beacon which will continue to be a part of the Canadian navigation system. It provides the pilot with a means for obtaining a bearing on a specific geographic fix at which the NDB is located. NDB's are also used in conjunction with the ILS Markers as a compass locator and will also be used with DME as an enroute navigational aid providing both azimuth (NDB) and distance (DME) information.

FUNCTION

The function of the NDB is to broadcast a continuous radio signal with a carrier, selected in the 190-535kHz frequency band, which will be modulated by either 400Hz or 1020Hz morse code keyed signals to provide station identification. The carrier power is set in a range of 25 Watts to 4.0 Kilowatts depending on the coverage requirement of the facility.

In association with the NDB, a ground based beacon monitor receiver (BMRX) is used at a fixed location remote from the NDB site to provide a reference status monitoring point for the NDB broadcast signals. This will also be used to provide a limited remote maintenance monitoring function to the Control and Performance Monitoring System (CPMS).

NON-DIRECTIONAL BEACON (NDB)

FUNCTIONAL INPUTS				
FROM	LOC	NAME	STANDARD	LOC
FSS		Omega Corr		

FACILITY PRINCIPAL FUNCTIONS		
REQUIREMENT	DESCRIPTION	SPECIFICATION
	Bearing Reference Broadcast	
	Status Alarm Broadcast	
	Marker Location Reference	
	Maintenance Monitoring	
	Differential Omega Correction Broadcast	

FUNCTIONAL OUTPUTS				
LOC	NAME	STANDARD	TO	LOC
	Equip Stat		RMTCECTR	

EQUIPMENT TYPES

- o Non-Directional Beacon - ATB 04,05,06 T 21,22, URN 1001, FAN 1004,1005 NEL 7014,7015,7104, 7105,7602,7612 NEL 7702,7804,8001, 8002
- o BMRX - PHL 6804, CRC/ARA 07, NEL 7102,7608,8101
- o Omega Receiver Processor
- o
- o
- o
- o
- o
- o
- o
- o

FIGURE 4-32

CANADIAN AIRSPACE SYSTEM
SYSTEM DESIGN
LEVEL ONE

SEPTEMBER 1985

4.3.7.1 Non-Directional Beacon

The aeronautical beacon transmitter (Non-Directional Beacon - NDB) is a dual exciter/keyed transmitter that operates in the LF/MF band at 25 Watts to 4.0KW carrier power. It automatically transmits an omnidirectional beacon identification signal at preselected repetition rates. Provision is also made for special codes to be transmitted when the primary exciter/keyer comination is switched to the secondary exciter/keyer combination or when commanded from an external source. Provisions are also made for press-to-talk (PTT) voice telephony. Both the tone identification and voice signal utilize amplitude modulation. Emission is amplitude modulated compatible single sideband.

The NDB utilizes the modular assembly concept in its design for ease of maintenance and maximum flexibility in system configurations. Since aeronautical beacon transmitters must operate continuously, it has been traditional to duplicate the entire system, with an automatic switchover, to ensure continued transmission in the event of a failure of the main transmitter. Nautel's beacon transmitters incorporate a number of design innovations that eliminate the need for a second transmitter system.

In the critical power amplifier (PA) subsystem, a multiple, paralleled, module/combiner network is utilised. Individual PA module outputs are totally isolated in the combiner network so that a loss of one cannot affect the remainder. Several PA modules must fail before the final output power reduction exceeds -3db.

The exciter/keyer functions have been duplicated. This built-in redundancy provides a standby drive to the PA modules when a failure in the primary exciter or keyer is detected.

The RF output is constantly monitored, by internal circuity, for quality and level. If an out-of-tolerance condition is detected, the exciter/keyer function is automatically switched from the primary unit to the secondary one. Provision is made to automatically change the coded transmission to a preselected standby code when the secondary system has been activated. Transmission of the standby code will alert system maintainers that a malfunction has occurred. Provision is also made to activate up to two standby codes from external sources to alert system maintainers of other problems, such as operating on a standby power system.

4.3.7.2 Beacon Monitor Receiver (BMRX).

The BMRX is a fixed-tuned, single channel, crystal controlled receiver that operates in the LF/MF (190 to 535 kHz) band. A superheterodyne circuit provides very high selectivity.

The main purpose of this equipment is to monitor the performance of an aeronautical beacon transmitter. Aural, visual, and remote alarms, provide a warning that:

(a) Beacon output power has decreased by more than 3db.

(b) Modulating level has decreased by more than 3db.

(c) Keying has stopped or become continuous.

(d) Beacon has switched from main to standby operating state.

The BMRX is failsafe. Component failure cannot increase the possibility of the normal state persisting during unsatisfactory beacon performance.

INTERFACES

Non-Directional Beacon (NDB)/Beacon Monitor Receiver (BMRX)/Control and Performance Monitoring System (CPMS). The NDB failure and maintenance status will be transmitted by the NDB and picked up by a remotely located BMRX. The status messages are demodulated and decoded by the receiver which will be interfaced to the Control and Performance Monitoring System (CPMS) via dial-up and public switched network.

Non-Directional Beacon (NDB)/Backup Power. In the event of a power failure the NDB will be powered by site located power supply which will be made up of various combinations of solar panels, wind generator, batteries, and diesel generator.

Non-Directional Beacon (NDB)/Omega Receiver-Processor. At selected locations, the NDB will transmit Omega correction factors obtained from a local Omega receiver/processor unit.

4.3.8 VERY LOW FREQUENCY (VLF)/OMEGA

PURPOSE

The VLF/OMEGA is a worldwide navigational system using very low frequency radio transmissions which will be used to provide aircraft with precise positioning data derived from phase measurement techniques. It will be used as a backup system to the ICAO approved VOR/DME and as a primary system for those areas of Canada that will not have VOR/DME coverage. This will be accomplished by the installation of two VLF/OMEGA stations in Canada to fill in those areas that do not at present have Omega coverage

VLF/OMEGA will provide the pilot with the capability for direct routings or random routings (RNAV).

FUNCTION

The function of each of the VLF/OMEGA transmitters is to broadcast a synchronized pulsed format (each pulse being approximately one second in duration) on 10.2kHz, 11.3kHz, and 13.6kHz. The transmitters are clocked so that, although all are transmitting the same frequencies, each station transmits a given frequency in a separate time slot and no two stations are transmitting the same frequency at the same instant. Each station transmits its three frequencies in sequence for about three seconds and then remains silent for about seven seconds until its turn comes up again.

The Omega system provides hyperbolic isophase contours on lines of position (LOP) between stations. Because of the wide separation of these transmitters on the spherical earth, the resulting grid appears to be nearly straight-line segments for a hundred miles or so on a typical local navigation chart.

Because predictable propagation effects can cause variations of as much as the LOP, or about 8 miles, at the 10.2kHz frequency over a 24 hour period, correction tables are published for all areas covered by the Omega. In general, users can anticipate a worst-case error of plus or minus two nautical miles at night and usually can do better when good correction data is available from tables or ground based monitors with corrections transmitted on NDB frequencies.

VERY LOW FREQUENCY (VLF)/OMEGA

FUNCTIONAL INPUTS				
FROM	LOC	NAME	STANDARD	LOC
RMTCECTR		Equip Ctl		

FACILITY PRINCIPAL FUNCTIONS		
REQUIREMENT	DESCRIPTION	SPECIFICATION
	Air Route Navigation Guidance	
	Omega Signal Monitor	
	Maintenance Monitoring	

FUNCTIONAL OUTPUTS				
LOC	NAME	STANDARD	TO	LOC
	Ops Status		FSS	
	Equip Stat		RMTCECTR	

EQUIPMENT TYPES	
o Omega Transmitter	o
o Omega Signal Monitor Receiver	o
o	o
o	o
o	o
	o

FIGURE 4-33

4.3.8.1 - 4.3.8.X (Very Low Frequency (VHF)/Omega Equipment Descriptions to be supplied during next phase)

4.3.9 VERY HIGH FREQUENCY DIRECTION FINDER (VHF/DF)

PURPOSE

The VHF Directional Finder (VHF/DF) is a ground based VHF receiver which will continue to be a part of the Canadian navigation system. It will be used to provide the Air Traffic Service facilities that are non-radar equipped with a means for locating and directing disoriented pilots.

FUNCTION

The VHF/DF is a receiver system designed to receive aircraft radio communications signals in the VHF aeronautical band. It receives and processes these signals and displays to the Air Traffic Service specialist an aircraft bearing relative to the VHF/DF site. The system consists of two parts: the antenna/bearing processor remote site and, connected by dedicated lines, the display/control unit at the specialist position.

A supporting function of the VHF/DF will be to monitor various maintenance and performance parameters and respond to maintenance control commands in support of the Control and Performance Monitoring System (CPMS).

INTERFACES

Very High Frequency Direction Finder (VHF/DF)/Control Tower/Flight Service Station. The Display Control Unit and the Remote Display unit are installed in the Control Tower or the Flight Service Station and interface directly with the the controller or flight service specialist. The display control unit provides to the controller or flight service specialist all the necessary alarms and controls to operate the VHF/DF.

Very High Frequency Direction Finder (VHF/DF)/Control and Performance Monitoring System (CPMS). The required maintenance status messages will be interfaced to the Area Maintenance Centre through a local interface and dial-up unit using the normal switched telephone network. However, in the event that dedicated lines will be required for other equipments at that location to interface to the CPMS, then the VHF/DF control and monitoring data will be transmitted over these same lines.

VERY HIGH FREQUENCY DIRECTION FINDER (VHF/DF)

FUNCTIONAL INPUTS				
FROM	LOC	NAME	STANDARD	LOC
TWR		Ops Ctl		
FSS		Ops Ctl		
RMTCECTR		Equip Ctl		

FACILITY PRINCIPAL FUNCTIONS		
REQUIREMENT	DESCRIPTION	SPECIFICATION
	Aircraft Direction Finding	
	Maintenance Monitoring	

FUNCTIONAL OUTPUTS				
LOC	NAME	STANDARD	TO	LOC
	A/C Brg		TWR	
	A/C Brg		FSS	
	Ops Status		FSS	
	Equip Stat		RMTCECTR	

EQUIPMENT TYPES	
o	o
o	o
o	o
o	o
o	o
o	o

FIGURE 4-34

CANADIAN AIRSPACE SYSTEM
SYSTEM DESIGN
LEVEL ONE

SEPTEMBER 1985

4.3.9.1 General Description (VHF/DF)

The VHF/DF is a ground based receiver system opeating in the VHF aeronautic communication band (118 to 137 MHz). It uses communication transmissions from an aircraft to produce a digital readout at the designated ATS specialist position of the aircraft bearing relative to the DF site to an overall accuracy of 3.0 degrees.

This system consists of five basic units:
- The receiver processor
- The amplifier processor
- The display control unit
- The antenna assembly
- The remote display unit

4.3.9.2 ANTENNA AND TOWER

The VHF DF Antenna, Model 7010-1 consists of one commutated, medium aperture array concentrically mounted on a 5-ft. high mast. The array is circular and consists of sixteen vertically polarized dipoles mounted on arms and equally spaced about the periphery of a 123.5-inch diameter circle. The dipole arms are flange mounted to a sixteen-sided antenna hub. Each dipole is sequentially connected (via a multiconductor cable) to the commutation generator in the receiver-processor through the RF commutator located within the antenna hub. A dual obstruction light fixture is located at the top fo the antenna hub to warn off low flying aircraft, and alightning rod is provided for protection.

4.3.9.3 RECEIVER PROCESSOR MODEL 7010-2

The receiver processor is a rack mounted, self-enclosed unit which contains all the circuitry necessary to process commutated RF signals received from the antenna array into a digital output suitable for transmission to the central control site over a single pair.

This unit is powered from a nominal 115 vac source available at the workbench in the equipment shelter. A REMOTE/LOCAL switch is provided on the panel to provide for channel selection at the receiver processor for ease of maintenance. Electrically, the receiver processor is divided into two separate sections.

The radio receiver section is a dual conversion superheterodyne type which amplifies, filters, and converts the selected commutated RF signal from the antenna array to an IF signal in one of the 12 possible frequency channels selected by the operator. Frequency selection is accomplished through use of either the rotary switch on the receiver processor front panel, or interlocked pushbuttons located on the display control unit located at the central control site. Each of the first six positions of the selector switch (paired with the first six pushbuttons) selects a front end printed circuit module which contains a crystal-controlled first conversion oscillator. In this way, RF amplification and pre-selection is provided for each channel.

The processor section provides circuitry for the electronic commutation of the antenna array and all facilities for system remote control and repeating of bearing information. In addition, circuitry for accomplishing the following functions is included:

- DF detection and filtering
- Time domain filtering
- Selectable integration for time averaging of received DF data
- Bearing quality evaluation
- Digital bearing and status enclodi
- ELT signal processing
- Bearing data self-test
- Automatic commutation stop

4.3.9.4 AMPLIFIER PROCESSOR MODEL 7010-3

The amplifier processor is a self-contained, rack mounted junction unit installed at the central control site. This unit contains all the logic required to interface the transmission line from the receiver processor with the display control unit and the remote display unit. Among the functions of the amplifier processor are:

- To receive and decode the serially-coded digital signals from the receiver processor.
- To provide a continuously updated display register output to the display units.
- To select control digital information for transmission to the receiver processor using control functions from the display control unit.
- To signal the operator when data transmission from the receiver processor is interrupted using an automatic self-test circuit.
- To receive audio transmissions from the receiver processor for driving the headphones at the display control unit.
- To decode other word type indicators from the receiver processor for display and control verification.

4.3.9.5 DISPLAY CONTROL MODEL 7010-4C

The display control is a rack mounted unti which is interconnected within 200 feet of the amplifier processor and mounted in a convenient location at the central control site. This unit provides the operator with an easily read digital readout (in degrees) of the received signal bearing and with all the controls necessary to operate the DF system. The readout section consists of a three digit, seven segment, flicker free display which is continuously updated by the amplifier processor. The display operates only when a signal is present and the data into the amplifier processor is determined to be valid. A ring-of-lights (ROL) display is also provided which consists of 72 light-emitting diodes (LED's) spaced at five degree increments around the digital readout. This display gives the operator a visual orientation of the received bearing.

4.3.9.6 REMOTE DISPLAY UNIT MODEL 7010-5

The remote display unit is also located at the central contorl site within 500 feet of the amplifier processor. This unit is driven from signals originating in the amplifier processor and presents the same digital readout of bearing as the main control display. The remote display unit contains its own power supply and operates from a nominal 115 vac 60 Hz source.

4.3.10 SATELLITE NAVIGATION MONITOR

PURPOSE

The satellite monitor is a ground based receiver system which will be part of the future Satellite Navigation System. It will be used to provide Air Traffic Service specialists with a means of deterimining whether the satellite navigation signals are useable. In the event that the signals are either out of tolerance or unavailable the specialist will advise aircraft within his control area of alternate facilities to use. In addition, Notams will be issued automatically for flight planning purposes.

FUNCTION

The satellite navigation ground monitor is a receiver system designed to receive data from navigation satellites and process and display this data for the Air Traffic Service specialist as an indication that the Satellite Navigation System is performing in accordance with its established tolerances. The processed data will be provided to the Notam service for automatic dissemination.

SATELLITE NAVIGATION MONITOR

FUNCTIONAL INPUTS				
FROM	LOC	NAME	STANDARD	LOC
FSS		Status Req		

FACILITY PRINCIPAL FUNCTIONS		
REQUIREMENT	DESCRIPTION	SPECIFICATION
	Enroute Navigation Guidance	
	Ground Monitoring of Signals	

FUNCTIONAL OUTPUTS				
LOC	NAME	STANDARD	TO	LOC
	Ops Stat		ACC	
	Ops Stat		TCU	
	Ops Stat		TWR	
	Ops Stat		FSS	

EQUIPMENT TYPES	
o Satellite Navigation Receiver/Processor	o
	o
o	o
o	o
o	o
o	o

FIGURE 4-35

CANADIAN AIRSPACE SYSTEM
SYSTEM DESIGN
LEVEL ONE

SEPTEMBER 1985

4.3.10.1 - 4.3.10.X (Satellite Navigation Equipment Descriptions to be supplied during next phase)

4.3.11 AIRPORT SURFACE NAVIGATION

PURPOSE

Airport Surface Navigation is a vehicular ADF receiver system which will be used within the airport confines. It will be used by airport emergency vehicles to locate themselves on the airport surface, thereby being able to travel to any point on the airport during periods of poor or zero visibility.

FUNCTION

The Airport Surface Navigation is a receiver system which receives and processes any three transmitted signals and displays the vehicle/receiver position to the vehicle operator on an airport map.

AIRPORT SURFACE NAVIGATION

FUNCTIONAL INPUTS				
FROM	LOC	NAME	STANDARD	LOC

FACILITY PRINCIPAL FUNCTIONS		
REQUIREMENT	DESCRIPTION	SPECIFICATION
	Provide Positional Information to Airport Ground Support Vehicles	

FUNCTIONAL OUTPUTS				
LOC	NAME	STANDARD	TO	LOC

EQUIPMENT TYPES	
o	o
o	o
o	o
o	o
o	o
o	o

FIGURE 4-36

4.3.11.1 - 4.3.11.X (Airport Surface Navigation Equipment Descriptions to be supplied during next phase)

4.4 WEATHER SENSOR FACILITIES

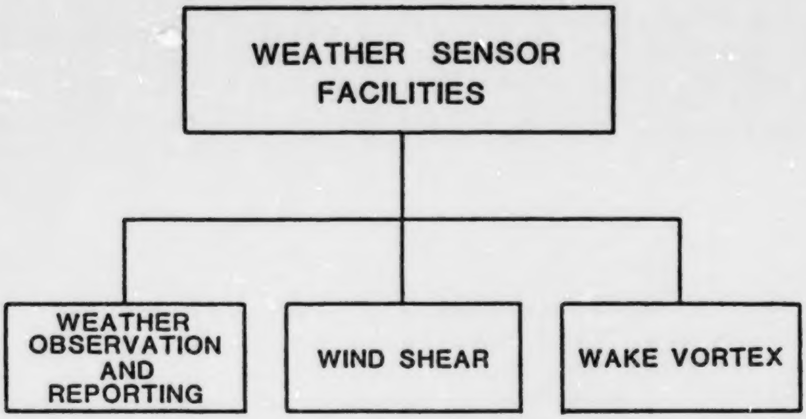

WEATHER SENSOR FACILITIES
WEATHER OBSERVATION AND REPORTING
WIND SHEAR
WAKE VORTEX

FIGURE 4-37

DESCRIPTION

The Weather Sensing facilities are those facilities which automatically sense, collect, and process meteorological data. Basic processing of the sensed data may be done by a processor associated with the weather sensing facility itself, or by a processor in another facility. In either case, additional processing, beyond that described for each of the weather sensing facilities, is generally done by other processors to make the data readily available and acceptable to the various users.

The Weather Sensing facilities are comprised of Weather Observation and Reporting, Wind Shear, and Wake Vortex.

4.4.1 WEATHER OBSERVATION AND REPORTING

PURPOSE

The Weather Observation and Reporting facility's purpose is to automate the acquisition of weather parameters with sufficient reliability and accuracy so as to be useful for aviation purposes. Additionally, it will supply the Atmospheric Environment Service (AES) with parameters that are suitable for aviation forecast production.

FUNCTION

Inputs from environmental sensors are processed and formatted for distribution to centralized data bases or for local dissemination and display. Parameters measured include: temperature; dew point; wind speed, direction and gusts; barametric pressure; visibility; precipitation; and cloud ceiling.

With the addition of voice synthesis equipment, local current weather parameters will be automatically broadcast to the pilot.

WEATHER OBSERVATION AND REPORTING

FUNCTIONAL INPUTS				
FROM	LOC	NAME	STANDARD	LOC
RMTCECTR		Mntnc Req		
RMTCECTR		Mntnc Ctl		

FACILITY PRINCIPAL FUNCTIONS		
REQUIREMENT	DESCRIPTION	SPECIFICATION
	Measure Temperature, Dew Point, Wind Speed, Wind Direction, Barometric Pressure Visibility, Ceiling and Precipitation	
	Synthesize Voice Message for Broadcast	
	Format Data Weather Message	
	Perform Self Monitoring	

FUNCTIONAL OUTPUTS				
LOC	NAME	STANDARD	TO	LOC
	Weather Bc		SINGLCOM	
	Weather Bc		MULTICOM	
	Weather Bc		VORDMTAC	
	Wx Data		ACC	
	Wx Data		TCU	
	Wx Data		TWR	
	Wx Data		FSS	
	Wx Data		AVWXCTR	
	Mntnc Data		RMTCECTR	

EQUIPMENT TYPES

o Weather Sensors
o Voice Synthesizer
o Data Processors
o
o
o

o
o
o
o
o
o

FIGURE 4-38

CANADIAN AIRSPACE SYSTEM
SYSTEM DESIGN
LEVEL ONE

SEPTEMBER 1985

4.4.1.1 - 4.4.1.X (Weather Observation and Reporting Equipment
Descriptions to be supplied during next phase)

4.4.2 WIND SHEAR

PURPOSE

To detect hazardous wind shear conditions in the vicinity of the airport.

FUNCTION

Processes data from wind measurement devices and transmits the data to the Tower.

Processes maintenance and control function data to and from the Area Maintenance Centre.

WIND SHEAR

FUNCTIONAL INPUTS				
FROM	LOC	NAME	STANDARD	LOC
RMTCECTR		Mntnc Req		
RMTCECTR		Mntnc Ctl		

FACILITY PRINCIPAL FUNCTIONS		
REQUIREMENT	DESCRIPTION	SPECIFICATION
	Predict and detect Wind Shears and processes and distributes to TCU's, TWR's, FSS's, regional weather processors, and MLS's	
	Maintenance remotely controlled	

FUNCTIONAL OUTPUTS				
LOC	NAME	STANDARD	TO	LOC
	Wind Shear		TWR	
	Mntnc Data		RMTCECTR	

EQUIPMENT TYPES	
o	o
o	o
o	o
o	o
o	o
o	o

FIGURE 4-39

CANADIAN AIRSPACE SYSTEM
SYSTEM DESIGN
LEVEL ONE

SEPTEMBER 1985

4.4.2.1 - 4.4.2.X (Wind Shear Equipment Descriptions to be supplied during next phase)

4.4.3 WAKE VORTEX

PURPOSE

To detect wake vortices caused by the arrival and departure of heavy jet aircraft.

FUNCTION

The facility will provide information to the Tower controller to permit the safe separation of aircraft. The facility will process the information from the wake vortex sensor and transmit it to the Tower controller. It will also process maintenance data which will be transmitted to the Area Maintenance Centre.

WAKE VORTEX

FUNCTIONAL INPUTS				
FROM	LOC	NAME	STANDARD	LOC
RMTCECTR		Mntnc Req		
RMTCECTR		Mntnc Ctl		

FACILITY PRINCIPAL FUNCTIONS		
REQUIREMENT	DESCRIPTION	SPECIFICATION
	Predict and detect Wake Vortex conditions and distributes to TWR's Maintenance remotely controlled	

FUNCTIONAL OUTPUTS				
LOC	NAME	STANDARD	TO	LOC
	Wake Vortx		TWR	
	Mntnc Data		RMTCECTR	

EQUIPMENT TYPES	
o	o
o	o
o	o
o	o
o	o
o	o

FIGURE 4-40

4.4.3.1 - 4.4.3.X (Wake Vortex Equipment Descriptions to be supplied during next phase)

CANADIAN AIRSPACE SYSTEM

TELECOMMUNICATIONS ELEMENT

5.0 TELECOMMUNICATIONS ELEMENT

This element comprises the facilities for National, Regional, and Local telecommunications. The facilities are defined generically and apply to three types of telecommunications.

All of these facilities make up the group called Interconnect Facilities.

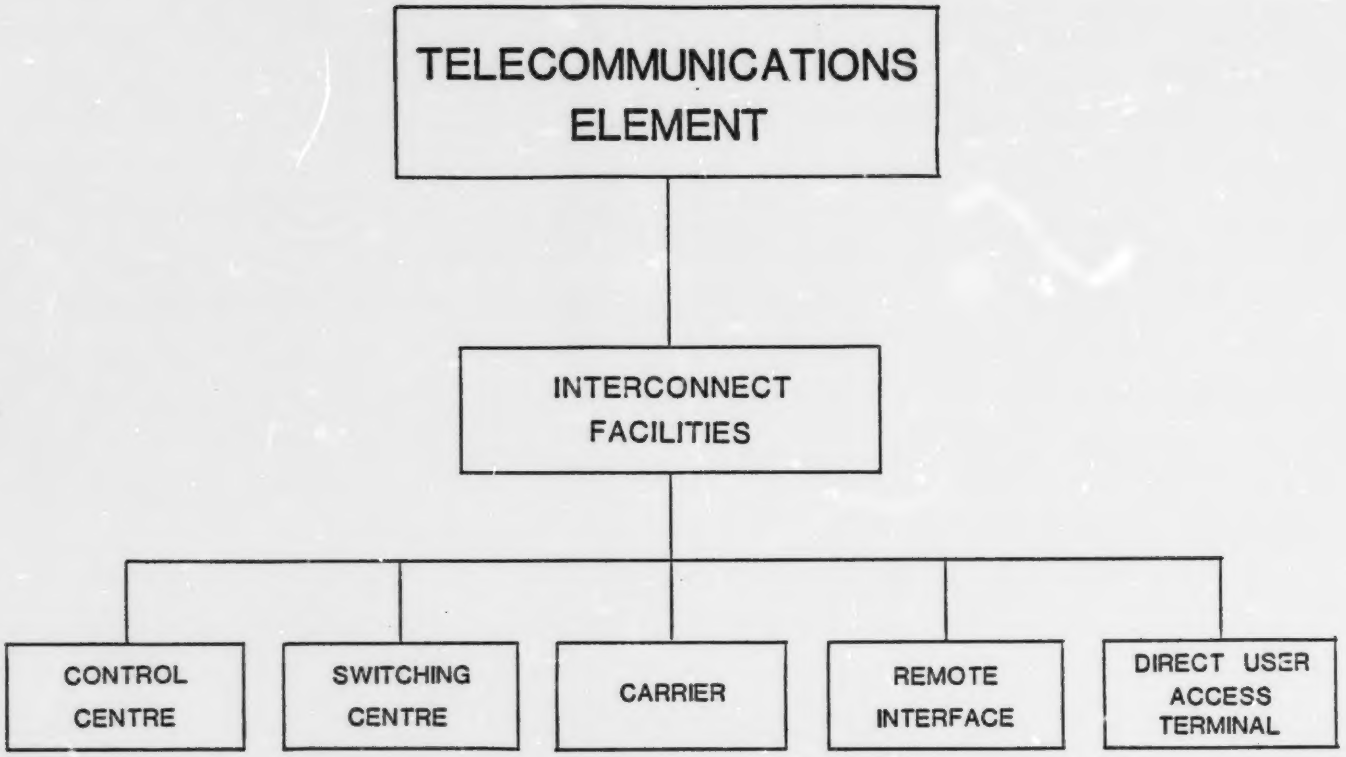

TELECOMMUNICATIONS ELEMENT
INTERCONNECT FACILITIES
CONTROL CENTRE
SWITCHING CENTRE
CARRIER
REMOTE INTERFACE
DIRECT USER ACCESS TERMINAL

FIGURE 5-1

5.1 INTERCONNECT FACILITIES

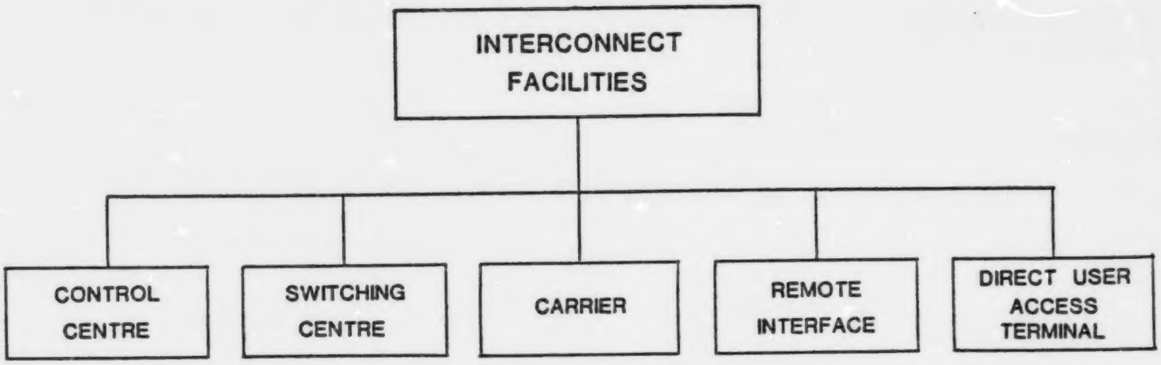

INTERCONNECT FACILITIES
CONTROL CENTRE
SWITCHING CENTRE
CARRIER
REMOTE INTERFACE
DIRECT USER ACCESS TERMINAL

FIGURE 5-2

DESCRIPTION:

These are telecommunications facilities that allow for the electronic transfer of information between and within all facilities within the Canadian Airspace System. The information received by and distributed from the facilities of this element will be in a standard digital form, even though its origin may be voice, data, or image, through switched or non-switched transmission media.

The principal entity of the Telecommunications Element is the Canadian Aeronautical Digital Network (CADIN). There will also be smaller networks point-to-point circuits and use of public telecommunications facilities to provide the complete service of the Element. All facilities will be under the control facilities of this Element.

The equipment used will be switches, interface devices, workstations, and carrier systems. The topography will include both network and point-to-point configurations.

5.1.1 CONTROL CENTRE

PURPOSE:

To provide monitoring and control of the facilities that comprise this Element.

FUNCTIONS:

The functions performed by the Control Centre include:

- Initiating of performance verification procedures.
- Receiving and maintaining performance reports.
- Execution of performance analyses. This includes comparison of performance against requirements and identification of requirements not being met.
- Maintenance of the Network Component Inventory.
- Planning and implementing national network reconfigurations. This includes creation and maintenance of standard reconfiguration plans and the execution of those plans in response to component failure indications.
- Planning and implementing network component replacement.

CONTROL CENTRE

FUNCTIONAL INPUTS				
FROM	LOC	NAME	STANDARD	LOC
RCTLCTR		Perf Rpt		
NSWITCH		Perf Rpt		
NRMTINT		Perf Rpt		
NCARRIER		Perf Rpt		
RCTLCTR		Config Rpt		
NSWITCH		Config Rpt		
NRMTINT		Config Rpt		
NCARRIER		Config Rpt		

FACILITY PRINCIPAL FUNCTIONS		
REQUIREMENT	DESCRIPTION	SPECIFICATION
	Initiate performance verification procedures	
	Receive and maintain performance reports	
	Execute performance analysis	
	Plan and implement national network configurations	
	Plan and implement national component replacements	

FUNCTIONAL OUTPUTS				
LOC	NAME	STANDARD	TO	LOC
	Perf Req		RCTLCTR	
	Perf Req		NSWITCH	
	Perf Req		NRMTINT	
	Perf Req		NCARRIER	
	Config Cmd		RCTLCTR	
	Config Cmd		NSWITCH	
	Config Cmd		NRMTINT	
	Config Cmd		NCARRIER	

EQUIPMENT TYPES	
o Computers	o
o Workstatiions	o
o	o
o	o
o	o
o	o

FIGURE 5-3

CANADIAN AIRSPACE SYSTEM
SYSTEM DESIGN
LEVEL ONE

SEPTEMBER 1985

5.1.1.1 CONTROL CENTRE COMPUTER

It is intended to have a computing unit with backup. The computer will receive the functional inputs of the facility, execute the required processes and provide the functional outputs of the facility.

5.1.2 SWITCHING CENTRE

PURPOSE:

To receive signals from and to redistribute signals among other facilities.

FUNCTION:

The primary function of this facility is to:

- Receive and transmit signals from and to designated facilities.
- Distribute selected inputs to selected outputs (switch).
- Combine two or more inputs and send to one ouput (multiplex).
- Separate any input into two or more outputs (de-multiplex).
- Select some inputs for connection to an output (concentrate).
- Maintain routing plan.
- Detect and correct errors

NOTE: Point-to-point circuits, although not physically connected to a switch will be included with a Regional or National Switching Centre for such requirements as control and reporting.

SWITCHING CENTRE

FUNCTIONAL INPUTS				
FROM	LOC	NAME	STANDARD	LOC
SWITCH		ATS Voice		
SWITCH		ATS Data		
NONTCFAC		ATS Data		
FLOCOCTR		ATS Data		
ARU		ATS Data		
NONTCFAC		Wx Data		
AVWXCTR		Wx Data		
SWITCH		Wx Data		
SWITCH		Wx Request		
NMTCECTR		Equip Ctl		
RMTCECTR		Equip Ctl		
SWITCH		Equip Stat		
FLOCOCTR		Flow Mgmt		
SWITCH		Flow Mgmt		
NONTCFAC		AIP Info		
AIPCTR		AIP Info		
SWITCH		AIP Info		

FACILITY PRINCIPAL FUNCTIONS		
REQUIREMENT	DESCRIPTION	SPECIFICATION
	Transmit and receive signals to and from regional switches and other designated facilities	
	Distribute selected inputs to selected outputs (Switch)	
	Combine two or more inputs and send to one output (Multiplex)	
	Separate any input into two or more outputs (De-Multiplex)	
	Select some inputs for connection to an output (Concentrate)	
	Maintain routing plan	
	Detect and correct errors	
	NOTE: Point-To-Point circuits, although not physically connected to a switch will be included with a regional or national switch for such items as control and reporting.	

FUNCTIONAL OUTPUTS				
LOC	NAME	STANDARD	TO	LOC
	ATS Voice		SWITCH	
	ATS Data		SWITCH	
	ATS Data		NONTCFAC	
	ATS Data		FLOCOCTR	
	ATS Data		AIPCTR	
	ATS Data		ARU	
	Wx Data		SWITCH	
	Wx Data		FLOCOCTR	
	Wx Data		AIPCTR	
	Wx Data		ARU	
	Equip Ctl		SWITCH	
	Equip Stat		NMTCECTR	
	Flow Mgmt		FLOCOCTR	
	Flow Mgmt		SWITCH	
	AIP Info		NONTCFAC	
	AIP Info		AIPCTR	
	AIP Info		SWITCH	

EQUIPMENT TYPES	
o Switch	o
o Multiplex	o
o DeMultipl	o
o Protocol Converter	o
o Carrier Iinterface	o
o	o

FIGURE 5-4

CANADIAN AIRSPACE SYSTEM
SYSTEM DESIGN
LEVEL ONE

SEPTEMBER 1985

5.1.2.1 SWITCHING CENTRE EQUIPMENT

The equipment will consist of a communications switch capable of packet and/or circuit switching. All switches will be digital.

Peripheral equipment will be multiplexers and de-multiplexers as needed to employ the most cost effective carrier systems.

Other peripheral equipment will be line terminators and, where necessary, protocol converters. There may also be a requirement for analogue and/or digital converters.

The switch will be connected to the outside world through carrier and remote interface facilities.

5.1.3 CARRIER

PURPOSE:

To provide a means of transporting signals between any two facilities in the Canadian Airspace System.

FUNCTION:

Transport of signals.

CARRIER

FUNCTIONAL INPUTS				
FROM	LOC	NAME	STANDARD	LOC
All Inter-Connect Facs		Signals		

FACILITY PRINCIPAL FUNCTIONS		
REQUIREMENT	DESCRIPTION	SPECIFICATION
	Transport of Signals	

FUNCTIONAL OUTPUTS				
LOC	NAME	STANDARD	TO	LOC
	Signals		All Inter-Connect Facs	

EQUIPMENT TYPES

- Copper Twisted Pair Cable
- Copper Coaxial Cable
- Optical Fibre Cable
- Terrestial Radio
- Satellite Radio
-
-
-
-
-

FIGURE 5-5

5.1.3.1 CARRIER EQUIPMENT

The essential element of this facility is the transmission medium which may be cable or radio. Cable may be copper twisted pair, copper coaxial, or optical fibre. Radio may be terrestial or satellite.

5.1.4 REMOTE INTERFACE

PURPOSE:

This facility provides the connection between carriers and facilities not part of the Telecommunications Element. It also provides connection to Direct User Access Terminals (DUAT) and Private Direct User Access Terminals.

FUNCTION:

Is the physical connection between the two facility types together with any format protocol or other changes that may be required.

REMOTE INTERFACE

FUNCTIONAL INPUTS				
FROM	LOC	NAME	STANDARD	LOC
CARRIER		SIGNALS		
NON-		SIGNALS		
INTER-				
CONNECT				
FACS				
DUAT		SIGNALS		

FACILITY PRINCIPAL FUNCTIONS		
REQUIREMENT	DESCRIPTION	SPECIFICATION
	Physical Connection	
	Format Changes	
	Protocol Changes	

FUNCTIONAL OUTPUTS				
LOC	NAME	STANDARD	TO	LOC
	SIGNALS		CARRIER	
	SIGNALS		NON-	
			INTER-	
			CONNECT	
			FACS	
	SIGNALS		DUAT	

EQUIPMENT TYPES	
o	o
o	o
o	o
o	o
o	o
o	o

FIGURE 5-6

5.1.4.1 - 5.1.4.X (Remote Interface Equipment Descriptions to be supplied during next phase)

5.1.5 DIRECT USER ACCESS TERMINAL (DUAT)

PURPOSE:

To provide terminal facilities for users to access designated information sources in the Canadian Airspace System and to accept information from users for transmission to other facilities in the Canadian Airspace System.

FUNCTIONS:

The following are functions of the Direct User Access Terminal:

- To accept and verify information and requests from users.
- To format and transmit user information and requests.
- To receive and display information for the users.

DIRECT USER ACCESS TERMINAL (DUAT)

FUNCTIONAL INPUTS				
FROM	LOC	NAME	STANDARD	LOC
REMOTE INTRFACE		SystemInfo		

FACILITY PRINCIPAL FUNCTIONS		
REQUIREMENT	DESCRIPTION	SPECIFICATION
	Accept and verify user information and user requests Format and transmit user information and user requests Receive and display system information	

FUNCTIONAL OUTPUTS				
LOC	NAME	STANDARD	TO	LOC
	User Req		REMOTE INTRFACE	
	User Info		REMOTE INTRFACE	

EQUIPMENT TYPES	
o Keyboard	o
o Micro Processor	o
o Video Display	o
o Printer	o
o	o
o	o

FIGURE 5-7

CANADIAN AIRSPACE SYSTEM
SYSTEM DESIGN
LEVEL ONE

SEPTEMBER 1985

5.1.5.1 Direct User Access Terminal (DUAT) Equipment

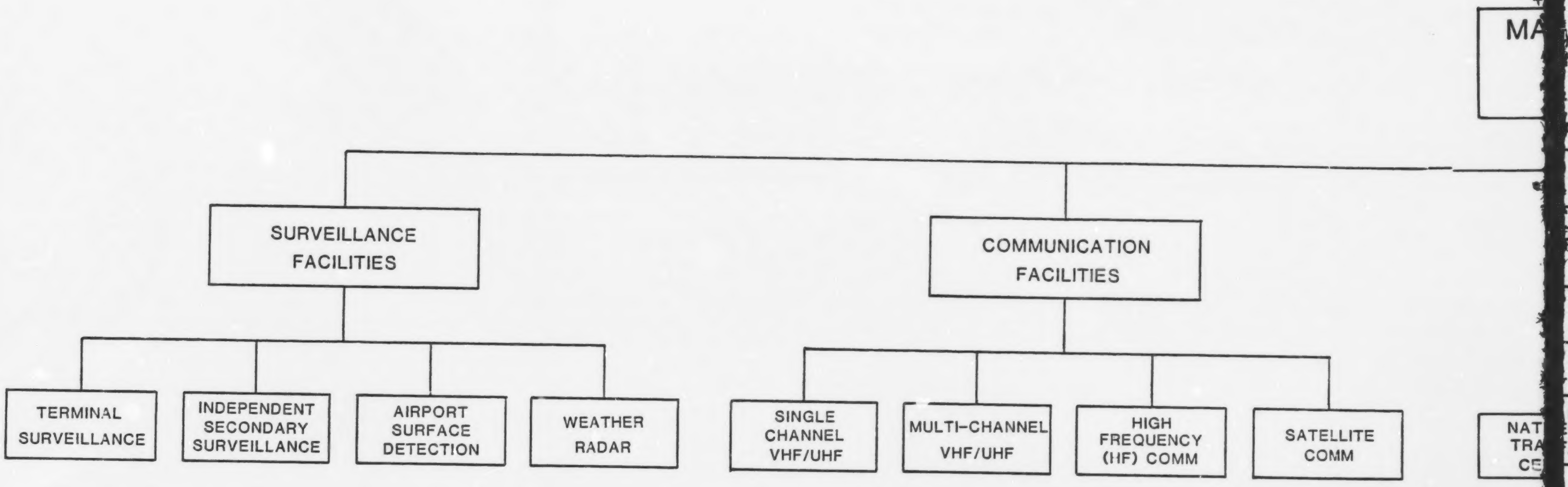
Keyboards, microprocessors, video displays, and printers are an integral part of the DUAT.

CANADIAN AIRSPACE SYSTEM

MAINTENANCE, TECHNICAL, AND SUPPORT ELEMENT

6.0 MAINTENANCE, TECHNICAL, AND SUPPORT ELEMENT

The Canadian Airspace Systems Plan's Maintenance, Technical, and Support Element provides; 1) Maintenance Facilities including National, Regional and Area Maintenance Centres; 2) Environmental Facilities which include electrical power, building and security; 3) Training Facilities made up of the National Training Center and Regional Air Traffic, Flight Services, and Facilities Engineering and Systems Development Training Facilities; 4) Research and Development Facilities comprised of the Test and Evaluation and Air Traffic Research, Experimentation and Simulation Centres; and Flight Inspection Facilities covering both the airborne and ground segments.


MA
SURVEILLANCE FACILITIES
COMMUNICATION FACILITIES
TERMINAL SURVEILLANCE
INDEPENDENT SECONDARY SURVEILLANCE
AIRPORT SURFACE DETECTION
WEATHER RADAR
SINGLE CHANNEL VHF/UHF
MULTI-CHANNEL VHF/UHF
HIGH FREQUENCY (HF) COMM
SATELLITE COMM
NAT
TRA
CE

FIGURE

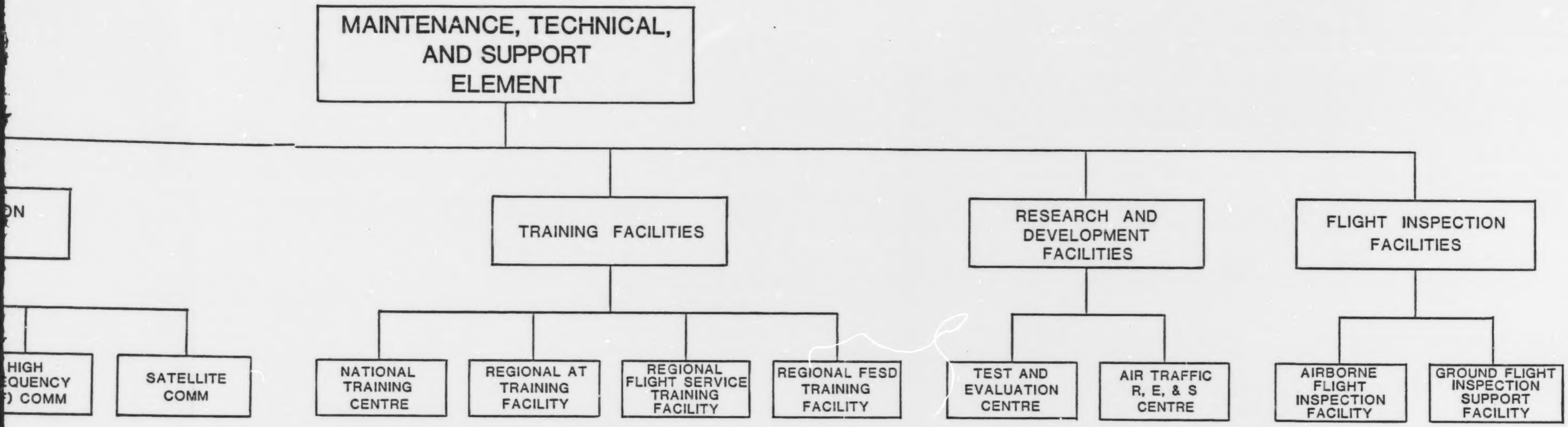

MAINTENANCE, TECHNICAL, AND SUPPORT ELEMENT
TRAINING FACILITIES
RESEARCH AND DEVELOPMENT FACILITIES
FLIGHT INSPECTION FACILITIES
HIGH
COMM
SATELLITE COMM
NATIONAL TRAINING CENTRE
REGIONAL AT TRAINING FACILITY
REGIONAL FLIGHT SERVICE TRAINING FACILITY
REGIONAL FESD TRAINING FACILITY
TEST AND EVALUATION CENTRE
AIR TRAFFIC R, E, & S CENTRE
AIRBORNE FLIGHT INSPECTION FACILITY
GROUND FLIGHT INSPECTION SUPPORT FACILITY

FIGURE 6-1

6.1 MAINTENANCE FACILITIES

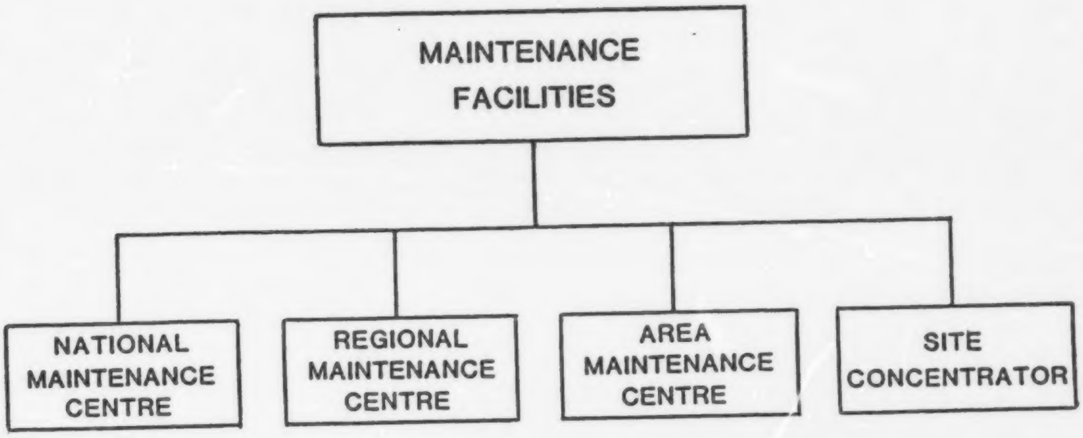

MAINTENANCE FACILITIES
NATIONAL MAINTENANCE CENTRE
REGIONAL MAINTENANCE CENTRE
AREA MAINTENANCE CENTRE
SITE CONCENTRATOR

FIGURE 6-2

DESCRIPTION

The Maintenance Facility will include the Control and Performance Monitoring System (CPMS), Calibration, Repair and Overhaul functions, Logistics, and other maintenance support requirements organized such that equipment feed into a Site Concentrator which then feeds the associated Area Maintenance Centre. All Area Maintenance Centres feed their respective Regional Maintenance Centre which in turn feeds the National Maintenance Centre. All equipment within the Canadian Airspace System will be retrofitted or designed so that remote maintenance and operations monitoring and control form a part of the Control and Performance Monitoring System.

6.1.1 NATIONAL MAINTENANCE CENTRE (NMC)

PURPOSE:

The National Maintenance Centre provides equipment maintenance support both to the Regional and Headquarters organizations. it acts as a central repair and overhaul centre as well as providing a back-up for regional level Maintenance Centres. The national Maintenance Centre will also provide managers with failure, availability, configuration, and workload statistics as well as special diagnostics capabilities. Additionally, it will be capable of providing to management and other facilities the equipment status at all Canadian Facilities. It provides national calibration and standards laboratories that support flight inspection and Regional Centres.

FUNCTION:

The basic equipment in the National Maintenance Centre will be identical to and have all the capabilities of the Regional Maintenance Centre configurations. It will receive equipment and site statistics and status from the Regional Maintenance Centres and create national data bases for recent and historic data. The Centre will provide for validation and verification of the Control and Performance Monitor System software and hardware as well as providing National configurations data for equipments and a master equipment certification parameter data base. With controlled access, the Centre will be capable of utilizing special diagnostics to assess field equipment problems and will provide central repair and overhaul facilities. The National Maintenance Centre will provide reports in support of national planning, programming and budgeting. The Centre will be accessable from the Regional, Area Centres, or Site Concentrators as well as by utilizing direct connect, dial-up, or cellular technology remote terminals. Network redundancy will be provided for, such that all centres at every level will be able to reliably communicate with their sources, peers and destinations.

NATIONAL MAINTENANCE CENTRE (NMC)

FUNCTIONAL INPUTS				
FROM	LOC	NAME	STANDARD	LOC
RMTCECTR		Reg Rollup	TESP	
RMTCECTR		RMC Status	TESP	
ANYWHERE		Rmote Term	TESP	
OPSPOSN		Lcl Term	TESP	
RMTCECTR		Cmd Report	TESP	

FACILITY PRINCIPAL FUNCTIONS		
REQUIREMENT	DESCRIPTION	SPECIFICATION
	National Status and Statistics	
	Provide RMC Backup	
	CPMS Verification and Validation	
	Master Equipment Parameter Data Base	
	National Problem Solution Data Base	
	National Reports Generation	
	Provide National OPS, RM Feed	
	National Configuration Control - Parts and Equipment	

FUNCTIONAL OUTPUTS				
LOC	NAME	STANDARD	TO	LOC
	Nat Rollup	TESP	OPS PSN	
	CmdRequest	TESP	RMTCECTR	
	LclDisplay	TESP	OPS PSN	
	Req Status	TESP	RMTCECTR	

EQUIPMENT TYPES	
o	o
o	o
o	o
o	o
o	o
o	o

FIGURE 6-3

CANADIAN AIRSPACE SYSTEM
SYSTEM DESIGN
LEVEL ONE

SEPTEMBER 1985

6.1.1.1 NATIONAL MAINTENANCE CENTRE PROCESSOR (NMCP)

PURPOSE:

The National Maintenance Centre Processor (NMCP) will interface with the Regional Mainentence Centre Processor (RMCP) network as well as being capable of direct Site Multiplexer (SM) connection in order to provide for national maintenance data roll-up, RMCP back-up, and the capability to display the national operational situation.

FUNCTION:

The NMCP will be a duplicate of the RMCP systems with the capability of backing-up a failed RMCP in a gracefully degraded mode. Terminals will be provided for life cycle and senior managers for investigation, statistics and reporting purposes.

INTERFACES:

National Maintenance Centre Processor/Regional Maintenance Centre Processor. Regional data will be consolidated, packetted, and forwarded to the National Maintenance Centre. All National Maintenance Centre Processor commands will be validated through the Regional Maintenance Centre Processor

National Maintenance Centre Processor/Site Multiplexer. As the Area Maintenance Centre Processor/Site Multiplexer interface.

National Maintenance Centre Processor/Area Maintenance Centre Processor. Area data will be consolidated, packetted, and forwarded to the Reqional Maintenance Centre. Command request will be forwarded to the Regional Maintenance Centre for approval.

6.1.2 REGIONAL MAINTENANCE CENTRES (RMC)

PURPOSE:

The Regional Maintenance Centres (RMC) will provide equipment maintenance support to each Regional organization and will be the computing centres for the Control and Performance Monitoring System.

FUNCTION:

RMC's accept or may require status, control, adjustment, diagnostics, or certification information actions. Status information includes equipment, security, alarm, failure, power, network, environmental and operational information. The centres act as the master security and validation point for controlling and monitoring all equipment of a given Region, as well as providing back-up for the other RMC's. Data from Area Maintenance Centres is consolidated for the Region, formatted for local reports and retention and forwarded to the National Maintenance Centre. The Centre provides for expert failure analysis to the lowest replaceable unit for all equipment in the Region and does trend analysis and outage forecasting. The configuration and modification status of all equipment is recorded and the centre establishes service call and site sortie scheduling to ensure optimal travel.

Requests may originate locally, from the NMC, other RMC's, AMC's, Site Concentrators, or remote terminals.

REGIONAL MAINTENANCE CENTRE (RMC)

FUNCTIONAL INPUTS				
FROM	LOC	NAME	STANDARD	LOC
AMTCECTR		AMC Status	TESP	
AMTCECTR		AMC Status	TESP	
AMTCECTR		CmdRequest	TESP	
SITECON		CmdRequest	TESP	
RMTCECTR		CmdRequest	TESP	
ANYWHERE		RemoteTerm	TESP	
OPS PSN		Local Term	TESP	
AMTCECTR		Cmd Report	TESP	

FACILITY PRINCIPAL FUNCTIONS		
REQUIREMENT	DESCRIPTION	SPECIFICATION
	Collect and Consolidate AMC. SC. and Equipment Status and Maintenance Information	
	Collect and Consolidate Personnel Data and Funds Data	
	Provide Regional Level Reports	
	Provide Expert Failure Analysis to LRU	
	Maintain Configuration Data Base	
	Provide Services and Sortie Scheduling	
	Outage Forecasting and Trend Analysis	
	Remote Control, Adjustments, and Certification	
	Validates Commands to Equipment	

FUNCTIONAL OUTPUTS				
LOC	NAME	STANDARD	TO	LOC
	Reg Rollup	TESP	AMTCECTR	
	Commands	TESP	AMTCECTR	
	LclDisplay	TESP	OPS PSN	
	Req Status	TESP	AMTCECTR	

EQUIPMENT TYPES	
o RMC Processor	o
o Terminals	o
o Printers	o
o	o
o	o
o	o

FIGURE 6-4

6.1.2.1 REGIONAL MAINTENANCE CENTRE PROCESSOR (RMCP)

PURPOSE:

The Regional Maintenance Centre Processor (RMCP) will interface with the network to collect information from Area Maintenance Centres within the Region. It will provide for data processing, storage and data forwarding, command validation, security control and NMC and neighbour RMC backup.

FUNCTION:

The RMCP will consist of a networked computer system with peripheral equipment including data terminal, high resolution colour graphic displays with one projection system, appropriate bulk storage and backup media, high speed autodial and answer modems, and letter quality and high speed graphic and alpha-numeric printers.

INTERFACES:

Regional Maintenance Centre Processor/Area Maintenance Centre Processor. Area data will be consolidated, packetted, and forwarded to the Reqional Maintenance Centre. Command requests will be forwarded to the Regional Maintenance Centre for approval.

Regional Maintenance Centre Processor/National Maintenance Centre Processor. Regional data will be consolidated, packetted and forwarded to the NMC. All NMCP equipment commands will be validated through the RMCP.

Regional Maintenance Centre Processor/Site Multiplexer. A dial up link, will be provided.

6.1.3 AREA MAINTENANCE CENTRE (AMC)

PURPOSE:

The Area Maintenance Centres (AMC) will be the only manned maintenance facilities. They will receive operational and maintenance data from the equipment at all sites within their area.

FUNCTION:

The AMC's will be capable of requesting and accepting all site and equipment information from the Site Concentrators. They will provide statistical analysis and forward consolidated data to their Regional Maintenance Centres. They will accept control, adjustment, diagnostic and certification requests for authorization by the RMC and they will implement approved requires. They may also on an exceptional basis and subject to security consideration, have immediate access to equipment. AMC's provide for local and remote input and format data to provide situation displays for equipment in their area. The AMC's will provide the facilities and equipment necessary to perform repair and overhaul all of the equipments within their area.

AREA MAINTENANCE CENTER (AMC)

FUNCTIONAL INPUTS				
FROM	LOC	NAME	STANDARD	LOC
ANYWHERE		RemoteTerm	TESP	
OPS PSN		Local Term	TESP	
RMTCECTR		Status	TESP	
RMTCECTR		Command	TESP	
SITECON		CmdRequest	TESP	
SITECON		Status	TESP	
NMTCECTR		Status	TESP	
SITECON		Cmd Report	TESP	

FACILITY PRINCIPAL FUNCTIONS		
REQUIREMENT	DESCRIPTION	SPECIFICATION
	Accept Requests and Consolidate Site Status Information	
	Accept Remote Terminal Input	
	Accept and Consolidate Maintenance Information	
	Provide Local Input and Data Formatting for Display	
	Process Diagnostic, Adjustment, Control, and Certification	
	Keep Site Concentrator Statistics	
	Provide for Remote Status, Control, Adjustment, Diagnostics and Certification	

FUNCTIONAL OUTPUTS				
LOC	NAME	STANDARD	TO	LOC
	Req Status	TESP	SITECON	
	AreaRollup	TESP	RMTCECTR	
	CmdRequest	TESP	RMTCECTR	
	Req Status	TESP	RMTCECTR	
	Req Status	TESP	NMTCECTR	

EQUIPMENT TYPES	
o RMC Processor	o
o Terminals	o
o Printers	o
o	o
o	o
o	o

FIGURE 6-5

6.1.3.1 AREA MAINTENANCE CENTRE PROCESSOR (AMCP)

PURPOSE:

The AMC Processor will interface with the network in order to collect equipment information from all Site Concentrators within its area of responsibility. It will provide for data processing, storage and data forwarding as well as the second level of security control and neighbour AMC backup.

FUNCTION:

The AMCP will have workstations to enable maintenance personnel to have the capability of interfacing with the Site Concentrators and the Regional Maintenance Centres. Area situational displays will be provided as well as the capability to interact with operational equipments. The processor will consolidate maintenance information and forward reports to the Regional Maintenance Centre.

INTERFACES:

Area Maintenance Centre Processor/Site Multiplexer. Site Multiplexer data will be received and consolidated.

Area Maintenance Centre Processor/Regional Maintenance Centre Processor. Area data will be consolidated packetted and forwarded to the RMC. Command requests will be forwarded to the RMC for approval.

6.1.3.2 TESTBEDS

PURPOSE:

To provide the capability of repairing and overhauling all equipment within the Area.

FUNCTION:

Substitution, comparison and automatic tests will be capable of being performed in order to diagnose faults so that repair can be effected and verified.

INTERFACES:

Local Site Multiplexer/Testbeds. In order to maintain the maintenance testbeds, they will have a local site multiplexer interfaced to the AMCP.

6.1.4 SITE CONCENTRATOR (SC)

PURPOSE:

The Site Concentrator will provide the local point to which all equipment will feed their equipment status, security status, alarm and failure status, power network, environmental and operational status. As well, the Site Concentrator will process status, control, adjustments, diagnostics, and certification requests and direct commands to the equipment or the Area Maintenance Centre as appropriate. Adjacent Site Concentrators will provide for a redundant Area Maintenance Centre network connection in the event of failure of the local Site Concentrator network interface.

FUNCTION:

The Site Concentrator will format equipment information for operational display and command purposes locally and will act as a smart switch and multiplexer, as appropriate, for the Area Maintenance Centre.

SITE CONCENTRATOR

FUNCTIONAL INPUTS				
FROM	LOC	NAME	STANDARD	LOC
AMTCECTR		Status Req		
AMTCECTR		Command		
ACC		Command		
TCU		Command		
TWR		Command		
FSS		Command		
GANDFSS		Command		
AIRFILAB		Command		
ACC		Status Req		
TCU		Status Req		
TWR		Status Req		
FSS		Status Req		
GANDFSS		Status Req		
AIRFILAB		Status Req		
FLOCOCTR		Status Req		
AIPCTR		Status Req		
ARU		Status Req		
AVWXCTR		Status Req		
ANYWHERE		RemoteTerm		
OPSPSN		Local Term		

FACILITY PRINCIPAL FUNCTIONS		
REQUIREMENT	DESCRIPTION	SPECIFICATION
	Process and Take Action on Approved Commands	
	Formats Information for Displays	
	Switching and Multiplexing for Area Maintenance Centre	

FUNCTIONAL OUTPUTS				
LOC	NAME	STANDARD	TO	LOC
	Status		AMTCECTR	
	CMDREPORT		AMTCECTR	
	CMDREPORT		ACC	
	CMDREPORT		TCU	
	CMDREPORT		TWR	
	CMDREPORT		FSS	
	CMDREPORT		AIRFILAB	
	Command		TSR	
	Command		ISSR	
	Command		ASDE	
	Command		WXRADAR	
	Command		SINGLCOM	
	Command		MULTICOM	
	Command		HFCOM	
	Command		SATCOM	
	Command		PRECNAPP	
	Command		NONPAPP	
	Command		VSUALAPP	
	Command		VORDMTAC	
	Command		NDB	
	Command		VLFNAV	
	Command		SATNAV	
	Command		VHFDF	
	Command		VOT	
	Command		SURFNAV	
	Command		AWORS	
	Command		WNDSHEAR	
	Command		WAKEVRTX	
	Status		ACC	
	Status		TCU	
	Status		TWR	
	Status		FSS	

EQUIPMENT TYPES	
○	○
○	○
○	○
○	○
○	○
○	○

FIGURE 6-6

SITE CONCENTRATOR

FUNCTIONAL INPUTS				
FROM	LOC	NAME	STANDARD	LOC

FACILITY PRINCIPAL FUNCTIONS		
REQUIREMENT	DESCRIPTION	SPECIFICATION

FUNCTIONAL OUTPUTS				
LOC	NAME	STANDARD	TO	LOC
	Status		AIRFILAB	
	Status		FLOCOCTR	
	Statur		AIPCTR	
	Status		ARU	
	Status		AVWXCTR	
	LclDisplay		OPSPSN	
	RmoteInput		AMTCECTR	
	CmdRequest		AMTCECTR	

EQUIPMENT TYPES	
o	o
o	o
o	o
o	o
o	o
o	o

FIGURE 6-6 (CONTINUED)

6.1.4.1 SITE MULTIPLEXER (SM)

PURPOSE:

This equipment will be the central signal transfer unit between all equipment for a site or group of equipment and the appropriate Site Control and Display Equipment (SCDE) and the Area Maintenance Centre. It will provide the first level of routing and security for the maintenance facility.

FUNCTION:

The equipment will collect and buffer commands and data going to and coming from site equipment. It will provide for packetting, formatting and coding as required to provide a single data stream.

INTERFACES:

Site Multiplexer/Equipment. All equipment status, security, alarm power, network, environment, control, adjustment, diagnostic commands and certification information will be fed to the site multiplexer.

Site Multiplexer/Area Maintenance Centre Processor. The Site Multiplexer will provide coded, formatted, and packetted data for transmission to and from the equipments and the Area Maintenance Centre.

Site Multiplexer/Site Control and Display Equipment. The Site Control and Display Equipment will receive and send equipment data via the Site Multiplexer.

6.1.4.2 SITE CONTROL AND DISPLAY EQUIPMENT (SCDE)

PURPOSE:

This equipment will provide all equipment control and operational information display for a given operational position.

FUNCTION:

The equipment will provide for directly issuing commands to equipment on an exceptional basis and for requesting approval for others from its RMC. It will provide high resolution colour display capability as well as other visual and audible outputs to provide all required operational information. The equipment will be modular in hardware and software utilizing the Common Controller Workstation (CCWS) module and worstation processor to enable on line integration of additional tasks.

INTERFACES:

Site Control and Display Equipment/Site Multiplexer. See 6.1.4.1

Site Control and Display Equipment/Other. To Be Determined

6.2 ENVIRONMENTAL FACILITIES

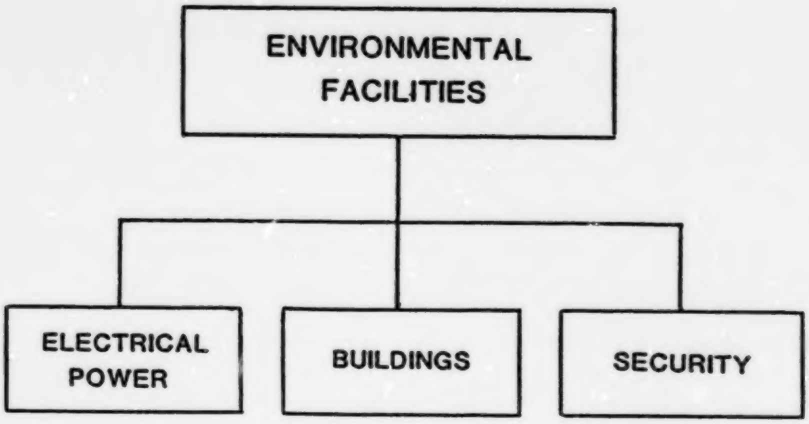


FIGURE 6-7

DESCRIPTION

As the Canadian Airspace System and its facilities are modernized, significant considerations must be given to those facilities that provide power to, house, and secure the functional activities of the Canadian Air Traffic Control and Airport System. Modernization of these facilities will include designing fault tolerant primary power systems and replacement of standby power systems; new or redesigned building structures that are more efficient and cost effective; and enhancing security systems to protect Canada's citizens and investments.

These facilities are collectively known as Environmental Facilities.

6.2.1 ELECTRICAL POWER

PURPOSE

To provide the optimum type and quality of primary and secondary (backup) electrical power to satisfy the current and future critical power requirements of the Canadian Airspace System and its facilities, systems, and equipment.

FUNCTION

The Electrical Power Facility provides the following functions to the facilities, systems, and equipment that it serves:

- Centralized distribution of primary power to all systems and equipment.
- Lightning and surge protection.
- Instantaneous availability of secondary power to designated critical facility requirements in the event of primary power failure.

ELECTRICAL POWER

FUNCTIONAL INPUTS				
FROM	LOC	NAME	STANDARD	LOC
NONTCFAC		Hydro		
RMTCECTR		Equip Ctl		

FACILITY PRINCIPAL FUNCTIONS		
REQUIREMENT	DESCRIPTION	SPECIFICATION
	Provide AC and DC Power of Specified Reliability and Availability to All Equipment in Each Facility	

FUNCTIONAL OUTPUTS				
LOC	NAME	STANDARD	TO	LOC
	Equip Stat		RMTCECTR	
	Equip Stat		RMCON	
	AC Power		All Fac	
	DC Power		All Fac	

EQUIPMENT TYPES

o Terminals
o
o
o
o
o
o
o
o
o
o
o

FIGURE 6-8

6.2.1.1 Power Transfer Equipment

6.2.1.2 Power Conditioning Systems

6.2.1.3 Lightning and Surge Protection Systems

6.2.1.4 Grounding and Shielding Systems

6.2.1.5 Static Uninterruptible Power Units

6.2.1.6 Uninterruptible Power Systems

6.2.1.7 Diesel Generators

6.2.1.8 Solar Power Systems

6.2.2 BUILDINGS

PURPOSE

To provide the structures necessary to house the facilities, systems, and equipment of the Canadian Airspace System.

FUNCTION

The functions of Buildings is to house and support the personnel, facilities, systems, and equipment that it serves as well as to provide:

- Heating, ventilation, and air conditioning.
- Lighting.
- Roads and parking for ingress and egress to the facility.

BUILDINGS

FUNCTIONAL INPUTS				
FROM	LOC	NAME	STANDARD	LOC

FACILITY PRINCIPAL FUNCTIONS		
REQUIREMENT	DESCRIPTION	SPECIFICATION

FUNCTIONAL OUTPUTS				
LOC	NAME	STANDARD	TO	LOC

EQUIPMENT TYPES	
o	o
o	o
o	o
o	o
o	o
o	o

FIGURE 6-9

6.2.2.1 Heating Systems

6.2.2.2 Ventilation Systems

6.2.2.3 Air Conditioning Systems

6.2.2.4 Lighting Systems

6.2.3 SECURITY

PURPOSE

To ensure the safety and security of the personnel, facilities, systems, and equipment in the Canadian Airspace System and, to some degree, the users of the system.

FUNCTION

The following are functions of Security:

- o Automatic monitoring of critical facility spaces.
- o Intruder alert at manned and unmanned facilities.
- o Detection of hazardous items and materials on persons and in baggage (checked and unchecked).

SECURITY

FUNCTIONAL INPUTS				
FROM	LOC	NAME	STANDARD	LOC
RMTCECTR		Mntnc Req		
RMTCECTR		Mntnc Ctl		

FACILITY PRINCIPAL FUNCTIONS		
REQUIREMENT	DESCRIPTION	SPECIFICATION
	Control Physical Access at Selected Airports Provide Records of Users	
	Screen Passengers and Carry-On Baggage by Detecting Metal and Explosive Vapors	
	Maintenance Remotely Controlled	

FUNCTIONAL OUTPUTS				
LOC	NAME	STANDARD	TO	LOC
	VideoAlarm		AIRLINES	
	VideoAlarm		AIRPORTS	
	VideoAlarm		RCMP	
	AudioAlarm		AIRLINES	
	AudioAlarm		AIRPORTS	
	AudioAlarm		RCMP	
	Data Alarm		AIRLINES	
	Data Alarm		AIRPORTS	
	Data Alarm		RCMP	
	Records		AIRPORTS	
	Records		RCMP	
	Records		RMTCECTR	
	Mntnc Data		RMTCECTR	

EQUIPMENT TYPES

- Card Access System
- Walk Through Detector
- Sniffers
- X-Ray Systems
- Alarms
- Metal Detectors

FIGURE 6-10

CANADIAN AIRSPACE SYSTEM
SYSTEM DESIGN
LEVEL ONE

SEPTEMBER 1985

6.2.3.1 Video Cameras and Recorders

6.2.3.2 Automatic Locking Systems

6.2.3.3 Alarm Systems

6.2.3.4 Keyed Entry Systems

6.2.3.5 X-Ray Detection Equipment

6.2.3.6 Electronic Sniffing Equipment

6.3 TRAINING FACILITIES

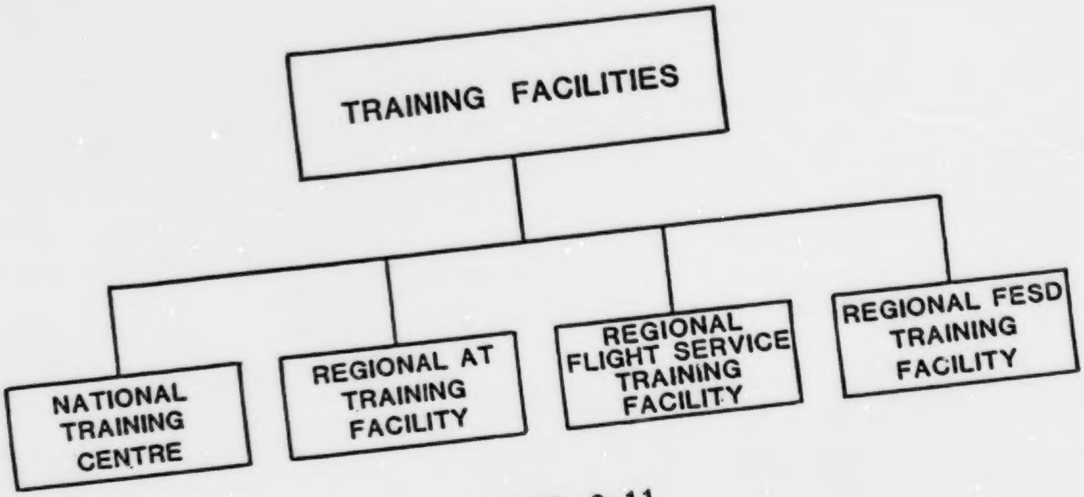

TRAINING FACILITIES
NATIONAL TRAINING CENTRE
REGIONAL AT TRAINING FACILITY
REGIONAL FLIGHT SERVICE TRAINING FACILITY
REGIONAL FESD TRAINING FACILITY

FIGURE 6-11

DESCRIPTION

Full-scale training programs must be accommodated to support modernization of the Canadian Airspace System. As well, the facilities to provide the training environments must also be organized, structured, and established.

The Training Facilities of this Element are so organized and are comprised of the National Training Centre, Regional Air Traffic Training Facility, Regional Flight Service Training Facility, and the Regional Facilities Engineering and Systems Development Training Facility.

The National Training Centre provides initial training to controllers and technicians as well as prototype training for new systems and equipment being introduced into the Canadian Airspace System. The Regional Training Facilities will provide proficiency and recurrent training to maintain or improve job skills on current air traffic control operations and procedures and technical systems and equipment.

6.3.1 NATIONAL TRAINING CENTRE

PURPOSE

The National Training Centre is located at the Transport Canada Training Institute at Cornwall and provides a centralized training facility for initial operations and technical and prototype training for new systems and equipment.

FUNCTION

The functions of the National Training Centre are to:

- Replicate operational and technical facilities for training purposes.
- Develop training programs for use at the National Training Centre.
- Develop training packages for use at regional training facilities.
- Provide initial and prototype instruction for Canadian Air Transportation Administration (CATA) personnel.
- Monitor, Analyze, and evaluate national and regional training programs.

NATIONAL TRAINING CENTRE

FUNCTIONAL INPUTS				
FROM	LOC	NAME	STANDARD	LOC

FACILITY PRINCIPAL FUNCTIONS		
REQUIREMENT	DESCRIPTION	SPECIFICATION

FUNCTIONAL OUTPUTS				
LOC	NAME	STANDARD	TO	LOC

EQUIPMENT TYPES	
○	○
○	○
○	○
○	○
○	○
○	○

FIGURE 6-12

CANADIAN AIRSPACE SYSTEM
SYSTEM DESIGN
LEVEL ONE

SEPTEMBER 1985

6.3.1.1 Computer Based Instruction Systems

6.3.1.2 Area Control Centre Training Simulator

6.3.1.3 Terminal Control Unit Training Simulator

6.3.1.4 Control Tower Training Simulator

6.3.1.5 Flight Service Station Training Simulator

6.3.1.6 Navigational Aids Training Simulator

6.3.1.7 Radar Training Simulator

6.3.1.8 Communications Training Simulator

6.3.1.9 Security Systems Training Simulator

6.3.1.10 Aircraft Avionics Training Simulator

6.3.1.11 Record, Playback, and Display Systems

6.3.2 REGIONAL AIR TRAFFIC TRAINING FACILITY

PURPOSE

To provide proficiency training for regional air traffic personnel assigned to Area Control Centres, Terminal Control Units, and Control Towers.

FUNCTION

The functions of the Regional Air Traffic Training Facility are to:

- Develop controller training packages.
- Provide proficiency training and evaluations.

REGIONAL AIR TRAFFIC TRAINING FACILITY

FUNCTIONAL INPUTS				
FROM	LOC	NAME	STANDARD	LOC

FACILITY PRINCIPAL FUNCTIONS		
REQUIREMENT	DESCRIPTION	SPECIFICATION

FUNCTIONAL OUTPUTS				
LOC	NAME	STANDARD	TO	LOC

EQUIPMENT TYPES	
o	o
o	o
o	o
o	o
o	o
o	o

FIGURE 6-13

CANADIAN AIRSPACE SYSTEM
SYSTEM DESIGN
LEVEL ONE

SEPTEMBER 1985

6.3.2.1 Area Control Centre Training Simulator

6.3.2.2 Terminal Control Unit Training Simulator

6.3.2.3 Control Tower Training Simulator

6.3.2.4 Record, Playback, and Display Systems

6.3.3 REGIONAL FLIGHT SERVICE TRAINING FACILITY

PURPOSE

To provide proficiency training for regional flight service personnel assigned to Flight Service Stations.

FUNCTION

The functions of the Regional Flight Service Training Facility are to:

- Develop flight service specialist training packages.
- Provide proficiency training and evaluations.

REGIONAL FLIGHT SERVICE TRAINING FACILITY

FUNCTIONAL INPUTS				
FROM	LOC	NAME	STANDARD	LOC

FACILITY PRINCIPAL FUNCTIONS		
REQUIREMENT	DESCRIPTION	SPECIFICATION

FUNCTIONAL OUTPUTS				
LOC	NAME	STANDARD	TO	LOC

EQUIPMENT TYPES	
o	o
o	o
o	o
o	o
o	o
o	o

FIGURE 6-14

6.3.3.1 Flight Service Station Training Simulator

6.3.3.2 Record, Playback, and Display Systems

6.3.4 REGIONAL FACILITIES ENGINEERING AND SYSTEMS DEVELOPMENT TRAINING FACILITY

PURPOSE

To provide recurrent training for regional Facilities Engineering and Systems Development presonnel.

FUNCTION

The functions of the Regional Facilities Engineering and Systems Development Facility are to:

- Develop technician training packages.
- Provide proficiency training and evaluations.

REGIONAL FACILITIES ENGINEERING AND SYSTEMS DEVELOPMENT
TRAINING FACILITY

FUNCTIONAL INPUTS				
FROM	LOC	NAME	STANDARD	LOC

FACILITY PRINCIPAL FUNCTIONS		
REQUIREMENT	DESCRIPTION	SPECIFICATION

FUNCTIONAL OUTPUTS				
LOC	NAME	STANDARD	TO	LOC

EQUIPMENT TYPES	
○	○
○	○
○	○
○	○
○	○
○	○

FIGURE 6-15

6.3.4.1 Maintenance Control Centre Training Simulator

6.3.4.2 Navigational Aids Training Simulator

6.3.4.3 Radar Training Simulator

6.3.4.4 Communications Systems Training Simulator

6.3.4.5 Security Systems Training Simulator

6.3.4.6 Record, Playback, and Display Systems

6.4 RESEARCH AND DEVELOPMENT FACILITIES

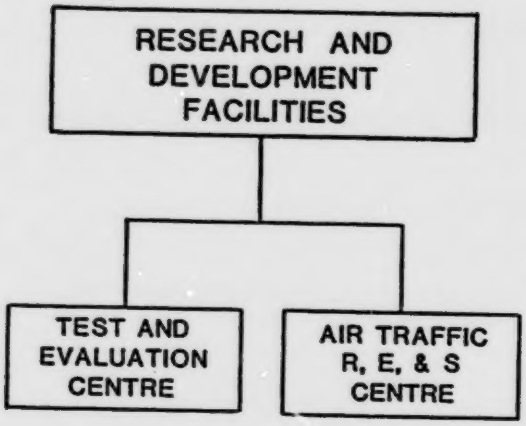

RESEARCH AND DEVELOPMENT FACILITIES
TEST AND EVALUATION CENTRE
AIR TRAFFIC R, E, & S CENTRE

FIGURE 6-16

DESCRIPTION

The Research and Development Facilities are those centres which provide technical support for: engineering development, design, and testing of new or enhanced electronic devices and systems; field support to and configuration management of designated field systems; and the simulation and evaluation of new or modified operational proceduresl.

The Research and Development Facilities are comprised Oof the Test and Evaluation Centre and the Air Traffic Research, Experimentation, and Simulation Centre.

6.4.1 TEST AND EVALUATION CENTRE

PURPOSE:

To adequately manage complex electronic systems throughout their life cycle an effective baseline to start measurement from is essential. The Test and Evaluation Centre provides this baseline by having production equipment operate in a controlled environment where essential performance measurements are taken and recorded regularly. This performance data base then forms the main source of information on how well operational systems fulfill performance requirements as specified in the design documents they were purchased under.

FUNCTION:

Reliability Growth Assessment

If a system is from a new design it is impossible to determine accurately what its mature performance will achieve in terms of specification requirements i.e., will it meet its Mean Time Between Failure (MTBF) and Mean Time To Repair (MTTR) specifications. A new design will take two to three years in field service to settle into its long term performance and achieve the minimum maintenance costs possible for the design.

Modified "off the shelf" designs will in most cases have a shorter maturing cycle depending on the degree of change injected by the modification. Similarily an engineering change introduced into the system will follow the same cycle.

Methodology is available to monitor the maturing cycle and to determine whether positive or negative results can be expected at the end of the maturation period.

Component Control

First, all failures have a cause and the test bed system will provide a method for assessing failure modes and effects.

Secondly, the rapid obsolesence of Integrated Circuit Technology methods will require extensive substitution of Integrated Circuits (IC) throughout the expected life of the system to move from one manufacturing technology to the next. The test bed system will be the source for the new component evaluation.

Software Verification and Validation

Just as component changes require verification and validation, software enhancement must go through a similar design and change development cycle to ensure that life cycle goals can be maintained. The baseline provided by the test bed system and its data base is essential to keep system performance within original specification limits.

Problem Resolution

To provide for cases where intermittent or complex malfunctions have occurred in an operating system it is necessary to simulate the conditions which were present when the malfunction occurred to fully determine the cause of the problem. The test bed systems will perform this function.

Simulation

New procedures for maintenance and operations will be validated in a controlled environment before introduction to operational systems.

Inputs for air traffic control exercises, training, and procedures development will be produced, minimizing the need for separate systems and consequent maintenance problems.

TEST AND EVALUATION CENTRE

FUNCTIONAL INPUTS				
FROM	LOC	NAME	STANDARD	LOC
E/Sites		CPMS D/Lin		
A. M. Cent		CPMS D/Lin		
R. M. Cent		CPMS D/Lin		
		UCR/PDR		

FACILITY PRINCIPAL FUNCTIONS		
REQUIREMENT	DESCRIPTION	SPECIFICATION
Ops Prblm Solutions	Stress Testing	
Mtce. Proc. V&V	Data Reduction	
Meas. Stds. Trace	Meas. Stds. ref.	
Component Subs.	Mtce. Proc. Dev.	
E/Data ATS	Std. Sys. Data Generation	

FUNCTIONAL OUTPUTS				
LOC	NAME	STANDARD	TO	LOC
	Eng. Chge		E/Sites	
	T. E. S. P.		E/Sites	
	Pblm Resol		All Poin	

EQUIPMENT TYPES

- o Systems Testbeds
- o Computing Equipment
- o Stress Test Equipment
- o
- o
- o Standards Laboratory
- o Drafting & Graphics
- o
- o
- o
- o

FIGURE 6-17

CANADIAN AIRSPACE SYSTEM
SYSTEM DESIGN
LEVEL ONE

SEPTEMBER 1985

6.4.1.1 Model Shop

The model shop provides support for development engineering and engineering change investigations. It will include a complete inventory of manufacturing facilities and tools.

6.4.1.2 Printed Wiring Board Facility

The facility will provide support for future development and engineering change investigation requirements and will include computer aided drafting and design software.

6.4.1.3 Wiring and Assembly Facility

The facility will provide the capability for loading printed wiring boards, wiring conventional chassis' and racks, fabricating interconnecting cables, and repair and overhaul of wiring.

6.4.1.4 Standards Facility

The primary standards facility will provide standard references for all Regional Calibration Laboratories.

6.4.1.5 Computing Facility

(To be supplied during next phase)

6.4.2 AIR TRAFFIC RESEARCH, EXPERIMENTATION, AND SIMULATION CENTRE

PURPOSE

The Air Traffic Research, Experimentation and Simulation Centre (ATRESC) simulates and evaluates present and new Air Traffic Service (ATS) functions and operating procedures, to study their impact on the Air Navigation System prior to operational use. As well, human factors research and development activities are carried out to define specifications in order to ensure that future systems, consoles, and workstations will be readily accepted by operational personnel.

FUNCTION

The systems and equipment located in the ATRESC provides for the replication of Area Control Centre, Terminal Control Unit, Tower and Flight Service Station Operations Rooms. All "outside world" inputs and outputs such as aircraft position information, weather, air-ground communications, interfacility communications, and data links, are simulated in order to provide realistic operational environments. Real time stop action and fast time simulation capabilities will provide cost effective means of evaluating procedures and collecting statistical data on alternatives under consideration. Interactive devices and supporting software will permit human factor aspects of man-machine interfaces to be evaluated. A general purpose flight simulator will be utilized in analysing detailed controller/pilot interactions as well as the interfacing between Flight Management Systems and automated ground air traffic control functions.

The Centre will also provide proof of performance support in the commissioning of operational ATS equipment. As well, software packages developed at the Centre will be adapted for use in controller training and proficiency evaluation simulation systems located in the field.

AIR TRAFFIC RESEARCH, EXPERIMENTATION, AND SIMULATION CENTRE

FUNCTIONAL INPUTS

FROM	LOC	NAME	STANDARD	LOC
ACC		Trng Voice		
TCU		Trng Voice		
FSS		Trng Voice		
TESTEVAL		Trng Voice		
ACC		Trng D/L		
TCU		Trng D/L		
FSS		Trng D/L		
TESTEVAL		Trng D/L		

FACILITY
PRINCIPAL FUNCTIONS

REQUIREMENT	DESCRIPTION	SPECIFICATION
	Replicate ACC, TCU, TWR, and FSS Operations Rooms	
	Simulate Aircarft Flight Position Surveillance Data (Flight Paths)	
	Simulate Weather Data	
	Simulate Air-Ground Data/Link Data	
	General Modelling (Fast Time Simulation)	
	Simulate aircraft/ controller interface functions	
	Simulate Interactions between ATC Functions and Flight Management Systems Functions	
	Simulate Psychological Interactions between Controllers and Flight Service Specialists and their Machines	

FUNCTIONAL OUTPUTS

LOC	NAME	STANDARD	TO	LOC
	SimSurv DA		ACC	
	SimSurv DA		TCU	
	SimSurv DA		FSS	
	SimSurv DA		TESTEVAL	
	Sim Wx DA		ACC	
	Sim Wx DA		TCU	
	Sim Wx DA		FSS	
	Sim Wx DA		TESTEVAL	
	Sim Pil DA		ACC	
	Sim Pil DA		TCU	
	Sim Pil DA		FSS	
	Sim Pil DA		TESTEVAL	
	Sim D/L		ACC	
	Sim D/L		TCU	
	Sim D/L		FSS	
	Sim D/L		TESTEVAL	

EQUIPMENT TYPES

- o Central Computer Complex
- o Pilot Positions
- o Common Controller/ FSS Workstation
- o
- o Communications Control Systems
- o Flight Simulator
- o Visual Tower Simulator
- o Recording, Playback, and Display System

FIGURE 6-18

6.4.2.1 CENTRAL COMPUTER COMPLEX (CCC)

PURPOSE

The Central Computer Complex will perform the key simulation functions for the facility. It provides for the generation, execution, and analysis of airspace and air traffic exercises. during exercise execution, it provides realistic information and responses to actions performed at the controller and flight service specialist workstations.

FUNCTION

The major functions performed in the Central Computer Complex are:

(a) Exercise preparation processing provides automated support for the development of the various scenarios, which includes traffic situations, airspace characteristics, and controller and flight service station configurations required in any particular exercise.

(b) Exercise execution processing provides for the generation of aircraft flight paths in response to simulated pilot inputs or canned flight profiles and in accordance with performance characteristics of the aircraft. It provides surveillance information (radar and dependent surveillance) to the workstations. It provides for the simulation of weather data and modelling and predicts its effects on the aircraft flight paths, and supplies weather and aeronautical information to the workstations. It also provides for timing functions for event synchronization as well as exercise freeze and fast-time capabilities.

(c) Exercise analysis processing provides for statistical analysis of completed exercises, both for real-time and fast-time simulations.

(d) Fast-time simulation processing provides for cost-effective evaluations of alternative procedures and methodologies that would otherwise require excessive time and resources to conduct in real-time.

INTERFACES:

Central Computer Complex/Common Controller and FSS Workstations. The CCC transmits simulated surveillance, flight plan, weather aeronautical and timing information to the workstations for processing and display. It receives from the workstations commands entered by the controller or flight service specialist and workstation control settings, parameters and status for recording purposes,

Central Computer Complex/Simulated Pilot Positions. The CCC receives inputs from the pilot positions for controlling the flight paths of simulated aircraft and for creating data link messages from the simulated aircraft. It sends information to the pilot position on exercise events, on the traffic situation, on aircraft flight plan intentions, and on timing,

Central Computer Complex/Communications Control System. The CCC provides information to the Communications Control System for exercise set-up conditions, for sectorization reconfigurations and for time synchronization. Information from the Communications Control System on usage of circuits is provided to the CCC for exercise analysis purposes.

Central Computer Complex/Flight Simulator. The CCC transmits data link messages and timing information to the flight simulator, and receives aircraft position and performance data and data link messages from the flight simulator.

Central Computer Complex/Visual Tower Simulator. The CCC provides exercise information to the visual tower simulator for the creation of aircraft, vehicle, meteorological and runway geography visual displays. Timing information is also provided. Aeronautical and weather data is also provided to drive the tower simulator instruments.

Central Computer Complex/Recording, Playback and Display Systems. The CCC provides data and timing information to the recording, playback and display system, and also information regarding the equipment configuration of the exercise to be recorded. The recording, playback and display system provides recorded data to the CCC for the recreation of exercises of interest.

Central Computer Complex/Operational Systems. The CCC provides surveillance and data link messages to operational system for commissioning tests.

6.4.2.2 SIMULATED PILOT POSITION

PURPOSE

The pilot position equipment provides for pilot input and feedback for real-time control of simulated aircraft flight paths.

FUNCTION

The major functions performed by this equipment are to receive and process pilot input and transfers the commands to the central processing complex for generation of aircraft positional, performance, and flight plan route information. The position receives data from the Central Computer Complex on the aircraft positions and performance and utilizes alpha numerics and situation displays to provide this information to the pilot. Exercise prompts for specific actions are also provided to the pilots in this manner. A number of aircraft and aircraft types can be simulated from any one position.

INTERFACES:

Simulated Pilot Position/Central Computer Complex. The CCC receives inputs from the pilot positions for controlling the flight paths of simulated aircraft and for creating data link messages from the simulated aircraft. It sends information to the pilot position on exercise events, on the traffic situation, on aircraft flight plan intentions, and on timing,

Simulated Pilot Position/Communications Control System. Communications between the simulated pilot position and the workstations is provided by the Communications Control System. for commissioning tests of operational systems, the communications control system provides communications between the simulated pilot positions and the operational system in the field.

6.4.2.3 COMMUNICATIONS CONTROL SYSTEM

PURPOSE

The Communications Control System provides the communications capability for the various exercises.

FUNCTION

The major function is to provide links among the workstation positions, support positions, pilot positions (inlcuding the flight simulators), and maintenance positions of the facility. As well, a comprehensive statistical gathering and reporting capability on the usage of the communications circuits will be provided.

INTERFACES:

Communications Control System/Common Controller and FSS Workstations. The Communications Control System provides communications capabilities between all manned positions within the facility and supports the commissioning of operational systems as indicated under 6.4.2.2.

Communications Control System/Central Computer Complex. The CCC provides information to the Communications Control System for exercise set up conditions, for sectorization reconfigurations and for time synchronization. Information from the Communications Control System on usage of circuits is provided to the CCC for exercise analysis purposes.

Communications Control System/Flight Simulator. (To be determined)

Communications Control System/Visual Tower Simulator. (To be determined)

6.4.2.4 COMMON CONTROLLER AND FLIGHT SERVICE STATION WORKSTATION

PURPOSE

The workstations provide for exercise simulation and handles all input and output functions identically to operational workstations.

FUNCTION

Three types of workstations will be provided:

(a) Workstations identical to operational workstations for air traffic control.

(b) Workstations identical to operational workstations for Flight Service Stations.

(c) Advanced, flexible workstations equipped with state-of-the-art displays and interactive devices for evaluating and experimenting with new operational procedures and assessing related ergonomics.

INTERFACES:

Common Controller and FSS Workstation/Central Computer Complex. The CCC transmits simulated surveillance, flight plan, weather aeronautical and timing information to the workstations for processing and display. It receives from the workstations commands entered by the controller or flight service specialist and workstation control settings, parameters and status for recording purposes,

Common Controller and FSS Workstations/Communications Control System. The Communications Control System provides communications capabilities between all manned positions within the facility and supports the commissioning of operational systems as indicated under 6.4.2.2.

6.4.2.5 Flight Simulator

PURPOSE

The flight simulator permits comprehensive testing and evaluation of aircraft and air traffic control automation interactions as well as pilot and air traffic controller relationships.

FUNCTION

The general purpose flight simulator will simulate various types of aircraft performance and will transmit flight path and other performance information to the Central Computer Complex for processing into simulated surveillance information. It will have the capability of supporting Mode S, High Frequency, or Satellite data link simulations.

NTERFACES:

Flight Simulator/Central Computer Complex. The CCC transmits data link messages and timing information to the flight simulator, and receives aircraft position and performance data and data link messages from the flight simulator.

Flight Simulator/Communication Control System. (To be determined)

6.4.2.6 VISUAL TOWER SIMULATOR

PURPOSE

The Visual Tower Simulator provides the real-time view as seen through a Control Tower's windows.

FUNCTION

The major function of this simulator is to provide high resolution perspective graphics processing and display that takes inputs from the Central Computer Complex and portrays aircraft, vehicles, meteorological phenomena, and airport geography on large screens simulating what is seen through tower cab windows. Normal tower cab instruments and display equipment are driven from the Central Computer Complex in the same manner as the simulated workstations.

NTERFACES:

Visual Tower Simulator/Central Computer Complex. The CCC provides exercise information to the visual tower simulator for the creation of aircraft, vehicle, meteorological and runway geography visual displays. Timing information is also provided. Aeronautical and weather data is also provided to drive the tower simulator instruments.

Visual Tower Simulator/Communications Control System. (To be determined)

6.4.2.7 RECORDING, PLAYBACK, AND DISPLAY SYSTEM

PURPOSE

This system provides for the capability to remotely observe and record any workstation or position during an active exercise as well as to provide a playback capability for any exercise at a future time.

FUNCTION

The system, consisting of analog, digital, and video equipment, will record all significant information, including controller displays, controller actions, all voice communications, and all data required to repeat or reconstruct an exercise. Additionally, remote observation rooms will be provided with repeater displays of workstations, television screens, and audio facilities to provide real-time observation of exercises.

NTERFACES:

The recording, playback and display system provides non-obtrusive collection of all information required to remotely observe a real time or at a later date all manned positions in an exercise.

Recording, Playback and Display System/Central Computer Complex. The CCC provides data and timing information to the recording, playback and display system, and also information regarding the equipment configuration of the exercise to be recorded. The recording, playback and display system provides recorded data to the CCC for the recreation of exercises of interest.

6.5 FLIGHT INSPECTION FACILITIES

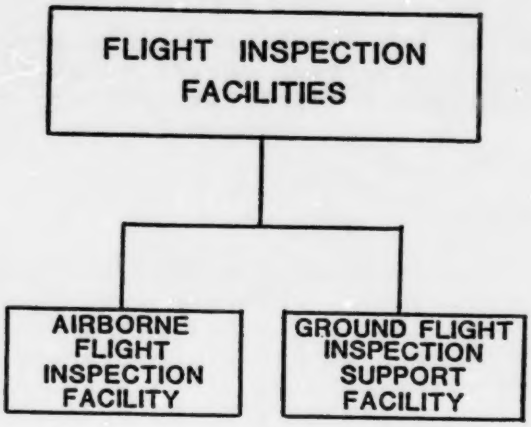

FLIGHT INSPECTION FACILITIES
AIRBORNE FLIGHT INSPECTION FACILITY
GROUND FLIGHT INSPECTION SUPPORT FACILITY

FIGURE 6-19

DESCRIPTION

Flight Inspection Facilities provide for airborne technical and operational evaluation of navigation, communications, and surveillance facilities. The Flight Inspection Facility consists of airborne and ground support facilities.

6.5.1 AIRBORNE FLIGHT INSPECTION FACILITY

PURPOSE

The Flight Inspection Facility provides for operational evaluation of procedures as well as technical assessments of equipment performance for surveillance, navigation, and communications facilities.

FUNCTION

The Flight Inspection of facilities provides for periodic certification of performance, site evaluation for new facilities, and calibration of commissioned equipment to reestablish performance within established criteria. In order to achieve this, aircraft are outfitted with precision sampling equipment and very accurate position determining systems.

AIRBORNE FLIGHT INSPECTION FACILITY

FUNCTIONAL INPUTS				
FROM	LOC	NAME	STANDARD	LOC

FACILITY PRINCIPAL FUNCTIONS		
REQUIREMENT	DESCRIPTION	SPECIFICATION
	Receive and Process Navigation, Radar, and Communications Signals	
	Provide Indication of Navigation, Radar, and Communications Coverage Volume	
	Operational Systems Certification	
	Provide Independent Indication of Aircraft Position (Flight Inspection Aircraft)	

FUNCTIONAL OUTPUTS				
LOC	NAME	STANDARD	TO	LOC
	Fac Cert		ACC	
	Fac Cert		TCU	
	Fac Cert		TWR	
	Fac Cert		FSS	
	Mntnc Data		NMTCECTR	

EQUIPMENT TYPES

o DFIS	o
o SCAPE	o
o	o
o	o
o	o
o	o

FIGURE 6-20

6.5.1.1 DIGITAL FLIGHT INSPECTION SYSTEM (DFIS)

PURPOSE:

The Digital Flight Inspection System equipment provides for automated sampling and processing of position and sensor data as well as automatic report generation and data archiving.

FUNCTION:

The Digital Flight Inspection System is a distributed computer system with highly stable and precise sampling peripherals for navigation, communications, and position data.

6.5.1.2 SELF CONTAINED AIRCRAFT POSITIONING EQUIPMENT (SCAPE)

PURPOSE:

The Self Contained Aircraft Positioning Equipment provides for ground independent aircraft positioning for the assessment of approach and enroute navigation facilities. It also provides positioning for radar and communications evaluations.

FUNCTION:

The Self Contained Aircraft Positioning Equipment employs an Inertial Naviation System, error models, smoothers, filters, Distance Measuring Equipment (DME) positions, and runway position to provide a highly accurate three dimensional flight inspection aircraft position.

6.5.2 GROUND FLIGHT INSPECTION SUPPORT FACILITY

PURPOSE

The Ground Flight Inspection Support Facility is used to produce and verify system hardware and software and to provide calibration and maintenance support for the airborne systems. As well, it provides for flight inspection mission scheduling and facility stability assessment.

FUNCTION:

The Ground Support Facility consists of two systems. A captive Digital Flight Inspection System and Software Generation centre and a management system to provide administrative support for aircraft deployment.

GROUND FLIGHT INSPECTION SUPPORT FACILITY

FUNCTIONAL INPUTS				
FROM	LOC	NAME	STANDARD	LOC

FACILITY PRINCIPAL FUNCTIONS		
REQUIREMENT	DESCRIPTION	SPECIFICATION

FUNCTIONAL OUTPUTS				
LOC	NAME	STANDARD	TO	LOC

EQUIPMENT TYPES	
o	o
o	o
o	o
o	o
o	o
o	o

FIGURE 6-21

CANADIAN AIRSPACE SYSTEM
SYSTEM DESIGN
LEVEL ONE

SEPTEMBER 1985

6.5.2.1 CAPTIVE DIGITAL FLIGHT INSPECTION SYSTEM (CDFIS)

PURPOSE:

This system will provide for a test and verification system for hardware and software modifications.

FUNCTION:

The system will be identical to operational systems with added programming and diagnostic facilities and will include simulated aircraft interfaces.

6.5.2.2 SOFTWARE GENERATION CENTRE (SGC)

PURPOSE:

This centre will provide hardware and software facilities to enable writing flight inspection software.

FUNCTION:

The Software Generation Centre (SGC) will be capable of preparing, integrating, and preliminary testing of software modules for the flight inspection system.

6.5.2.3 CALIBRATION STANDARDS

PURPOSE:

The Calibration Standards will be used to ensure accurate measurement capability for the flight inspection systems.

FUNCTION:

Periodically, the internal calibration system of the Digital Flight Inspection System (DFIS) will calibrate itself against standards transferred from the NRC standard set.

6.5.2.4 ADMINISTRATIVE COMPUTER SYSTEM

PURPOSE:

This system is to provide for efficient and effective use of the Flight Inspection Fleet and the Flight Inspection data.

FUNCTION:

The system will be used to do scheduling for the aircraft of the Flight Inspection Fleet in order to optimize productivity. As well, it will be used to assess the statistics from the data obtained from each facility.

CANADIAN AIRSPACE SYSTEM

ABBREVIATIONS AND DEFINITIONS

ABBREVIATIONS LISTING

A/C	Aircraft
Adj	Adjustment
Adv	Advise
Advsry	Advisory
Aero	Aeronautical
Aires	Air Reservation
AG	Air Ground
Alrt	Alert
App	Approach
Aprt	Airport
Apvl	Approval
Asnmt	Assignment
ATC	Air Traffic Control
Aud	Audio
Auth	Authorization
Az	Azimuth
BC	Broadcast
Brg	Bearing
Cal	Calibrate(s)
Cert	Certification
Cfm	Confirm
Chg	Change
Clr	Clearance
Cmd	Command
Com, Comm	Communications
Comp	Computer
Con	Concentrator
Config	Configuration
Conv	Convert
Corr	Correction
Ctl	Control
D/L	Data Link
DA	Data
Del	Delivery
Dist	Distance
Distrs	Distress
Elev	Elevation
Emgcy	Emergency
Equip	Equipment
F Pln	Flight Plan
FA	Facsimile
Fac	Facility
Fcst	Forecast
Flt Pln	Flight Plan
Gd	Guide
Gen	General
Gnd	Ground
GR	Graphics
H/W	Hardware
ID	Identification
Info	Information
Instr	Instrument
Interrog	Interrogate
Intl	International
Lcl	Local
Light	Lighting
LRU	Local Repair Unit
Mgmt	Management
Mntnc	Maintenance
Mntr	Monitor
Msg	Message
Nat	National
Nav	Navigation
Obs	Observation
Ops	Operations
O&M	Operations & Maintenance
PComm	Paid Communications
Perf	Performance
Pil	Pilot
Pri	Primary
Prob	Problem
Psn	Position

RA	Radar
Rec	Receive
Reg	Regional
Rev	Revise(d)
Req, Rq	Request
Res	Resolution
Rmote	Remote
Rnwy, Rwy	Runway
Rpt	Report
Rpr	Repair
Rply	Reply
Rqmt	Requirement
SAR	Search And Rescue
Sat	Satellite
Sig	Signal
Sim	Simulate(d)
Stat	Status
Subass	Subassembly
Surv	Surveillance
S/W	Software
Sync	Synchronize(r)(ing)
Sys	System
Term	Terminal
Tfc	Traffic
Tgt	Target
Trng	Training
Tst	Test
VC	Voice
Vid	Video
Vis	Visual
Vortx	Vortex
W/S	Wind Shear
W/V	Wake Vortex
Wx	Weather
X-ing	Crossing
Xmit	Transmit
Xpnd	Transponder

LEVEL ONE DEFINITIONS

REFERENCE	MNEMONIC	DEFINITION
01	AIRLINES	Airline Direct Link
02	ACC	Area Control Centre
03	TCU	Terminal Control Unit
04	TWR	Tower
05	FSS	Flight Service Station
06	GANDFSS	Gander Flight Service Station
07	DUAT	Direct User Access Terminal
08	PRIVDUAT	Private Direct User Access Terminal
09	NONTCFAC	Non-Transport Canada Facilities
10	FLOCTCTR	Flow Control Centre
11	AIPCTR	Aeronautical Information Centre
12	ARU	Airspace Reservation Unit
13	AVWXCTR	Aviation Weather Centre
14	TSR	Terminal Surveillance Radar
15	ISSR	Independent Secondary Surveillance Radar
16	ASDE	Airport Surface Detection Equipment
17	WXRADAR	Weather Radar
18	SINGLCOM	Single Communication Channel VHF/UHF
19	MULTICOM	Multiple Communication Channels VHF/UHF
20	HFCOM	High Frequency Communications
21	SATCOM	Satellite Communications
22	CAT1ILS	Category I ILS
23	CAT2ILS	Category II ILS
24	CAT3ILS	Category III ILS
25	VSUALAPP	Visual Approach Facility
26	VORDMTAC	VOR/DME/TACAN
27	NDB	Non-Directional Beacon
28	VLFNAV	Very Low Frequency Navigation
29	SATNAV	Satellite Navigation
30	VHF/DF	Very High Frequency Direction Finder
31	VOT	VHF Omni Test
32	SURFNAV	Airport Surface Navigation
33	AWORS	Automatic Weather Observation Reporting
34	WNDSHEAR	Wind Shear
35	WAKEVRTX	Wake Vortex
36	CADINCTL	Canadian Aeronautical Data Information Network Control
37	CIRCUIT	Carrier
38	SWITCH	Switch
39	NMTCECTR	National Maintenance Centre
40	RMTCECTR	Regional Maintenance Centre
41	AMTCECTR	Area Maintenance Centre
42	SITECON	Site Concentrator
43	ELECTPWR	Electrical Power
44	BLDGS	Buildings
45	SECURITY	Security
46	TCTI	Transport Canada Training Institute
47	RATSKOL	Regional Air Traffic Services School
48	RFSSSKOL	Regional FSS Training Facility
49	RFSDSKOL	Regional FESD Training Facility
50	ATR&ECTR	Air Traffic Research and Evaluation Centre
51	AIRFILAB	Airborne Flight Inspection Laboratory

52	GNDFISPT	Ground Flight Inspection Support
53	AIRCRAFT	Aircraft
54	CTLCTR	Control Centre
55	SWICHCTR	Switching Centre
56	CARRIER	Carrier
57	RMTINTFC	Remote Interface
58	RMTCETRM	Remote Maintenance Terminal
59	EQUSTAT	Equipment Status
60	SECSTAT	Security Status
61	ALMSTAT	Alarm Status
62	PWRSTAT	Power Satus
63	OPSTAT	Operational Status
64	NETSTAT	Network Status
65	ENVSTAT	Environment Status
66	ANYWHERE	Anywhere
67	ALLPLACE	All Places
68	REQUSTAT	Request Equipment Status
69	RSECSTAT	Request Security Status
70	RALMSTAT	Request Alarm Status
71	RPWRSTAT	Request Power Status
72	ROPSTAT	Request Operational Status
74	RNETSTAT	Request Network Status
75	RENVSTAT	Request Environment Status
76	DMCTSC	TSC/DMC Facility

Volume

5

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CANADIAN AIRSPACE SYSTEM

VOLUME V OUTLINES OF SYSTEM DESIGN LEVELS II, III, AND IV

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CANADIAN AIRSPACE SYSTEM

VOLUME 5: OUTLINES OF SYSTEM DESIGN LEVELS II, III AND IV

by

Jerry Thompson &	James F. Hickling
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PREPARED FOR THE CANADIAN AIR TRANSPORTATION ADMINISTRATION
AND THE
TRANSPORTATION DEVELOPMENT CENTRE

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17. Abstract

The Canadian Airspace System Plan (CASP) is a comprehensive plan for modernizing and improving the Canadian Airspace System. There are literally thousands of air traffic control and air navigation facilities comprising the Canadian Airspace System. Projects to modernize these facilities are in various stages of implementation. Implementation of some projects may dictate changes in, or alterations to, air traffic procedures, aircraft equipage, or flight procedures as well as impacting other projects. The Canadian Airspace Systems Engineering Plan describes a unique systems engineering based approach for organizing and managing the implementation of CASP.

Volume 1: Systems Engineering Management Implementation Plan: This report describes a series of systems engineering planning activities and processes; structures the many individual projects in the Canadian Airspace System Plan; describes a program management hierarchy; identifies tools available to support management; estimates the number of person-years of technical/engineering support required; mandates a series of specific actions required; and, reports progress on their implementation.
Volume 2: Program Management System (System Description);
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17. Abstract

Le Plan d'aménagement de l'espace aérien du Canada vise à moderniser l'organisation et la gestion de cet espace dont la surveillance fait appel à un nombre très élevé d'installations pour le contrôle de la circulation aérienne et la radionavigation. Ce Plan met en oeuvre un grand nombre d'actions ayant atteint un stade plus ou moins avancé et dont certaines implequent des modifications aux procédures de circulation aérienne ou de vol en vigueur, ou aux normes d'équipement des aéronefs. Pour la réalisation de ce Plan, une approche systémique est préconisée dans ce rapport. Le rapport comporte cinq parties:
Volume 1: Systems Engineering Management Implementation Plan; ce rapport décrit ou définit: les actions à lancer et les procédés à appliquer en matière de planification; l'ordonnancement général des nombreux éléments du Plan; les liaisons hiérarchiques à établir; les services de soutien au programme de gestion; le tableau estimatif des effectifs techniques à prévoir; et enfin, les progrès accomplis.
Les autres parties traitent plus en details des sujets suivants:
Volume 2: Program Management System (System Description);
Volume 3: Identification and Consolidation of Hierarchy of Documentation;
Volume 4: Level I System Design (to facility level);
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1.0 INTRODUCTION

The Canadian Airspace Systems Plan is a comprehensive plan for modernizing and improving the Canadian Airspace System. The work envisioned is almost overwhelming in its magnitude. The activities described are so large and complex that they must be addressed in a System Engineering context if there is to be any hope of successfully implementing the Plan in any reasonable timeframe and at any reasonable cost.

In preparing this Plan for implementing the Canadian Airspace Systems Plan, a number of factors were taken into consideration.

The long term support of the aviation community and the public is important. The continued support of aviation users and the public is likely dependent on delivery of some benefits in terms of enhanced safety, improved services, or reduced operating costs early in the implementation period. Achieving these early benefits will require a very carefully orchestrated integration of project outputs.

There are literally thousands of Air Traffic Control and Air Navigation facilities comprising the Canadian Airspace System. Some are to be retained, others are to be modified, and some are to be replaced. In the aviation community those services cannot be denigrated during implementation activities.

During the life of this program, Operational Performance Requirements will change. These changing requirements will be the result of changes in demand placed on the system or the emergence of changed or new technologies. Provisions must be made in the implementation plan to accommodate these changes even as the Program is moving forward.

The projects comprising the Canadian Airspace Systems Plan are in varius stages of implementation. Some are currently being installed in the field, others are in production, others are being planned, and some are yet to be developed. It is almost axiomatic that those activities which are nearest to completion are those which we can change the least (without disrupting the entire activity) and those which are the furthest from completion are more susceptible to change (again without disrupting the entire activity). Although this reality is a significant constraint on any implementation scheme, it must be accommodated.

Implementation of some systems dictate changes in, or alternations to, air traffic procedures, aircraft equipage, or flight procedures.

2.0 HIERARCHY

During every phase of activity, from planning, to design, to implementation, care must be taken to assure that any corresponding air traffic procedures required are practical and will be available. The same is true of aircraft equipage and flight procedures.

This document describes in outline form the components of the Levels II, III, and IV designs for the Canadian Airspace System.

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